ESTIMATION AND COSTING

Determination of Quantities of different Items of Work in Construction

KIRAN S R
Lecturer in Civil Engineering
Government Polytechnic College
DEPARTMENT OF TECHNICAL EDUCATION
Government of Kerala

Contents

Introduction

Why do we determine Quantities?

Introduction

Why do we determine Quantities?

- We know that, Cost of an item of work is determined from:

  Quantity x Rate = Cost

  Quantity:
  - the amount or number of a material estimated by spatial measurement.
  - expressed in Length, Area or Volume, determined by standard mensuration procedures/formula.

  Rate:
  - Cost of unit quantity of an item.
  - Referenced from Delhi Schedule of Rates (DSR) or Local Market Rates (LMR).

  Therefore, it is mandatory to determine quantites, for estimation of cost.

- For preparing **Detailed Estimate**, it is a necessity for the Estimator to determine the quantities of **each item of work** involved in the project.

Introduction

Basic Steps involved in Quantification of Items:

1. All items relevant to the work shall be **identified** from following sources:
   - building plans, detailed architectural & structural drawings,
   - preliminary lay-out drawings of the various services,
   - detailed specifications etc.
2. Further, each item of the project should be **broken down** into its parts and its **dimensions** (*Length, Breadth, Height, Diameter etc.*) measured.
3. **Quantities** (in terms of *running metres, area or volume*) are then determined using standard formulas of mensuration, in **tabular form**, as shown below.

Introduction

DETAILS OF MEASUREMENTS CPWD- 2

Name of Work.....

Details of Work/Item/Locaton	No.	Measurements			Quantities
		L	B	H	

- In booking dimensions, the order shall be consistent and in the sequence of Length (L), Width (B) and Height/depth/thickness (H).

IS 1200

- **IS 1200** (*Indian Standard Methods of Measurement of Building and Civil Engineering Works*) was published by *Bureau of Indian Standards*, with the intend to bring **uniformit**y in the methods of measurement of Civil Engineering works and to **standardize** the same.
- Therefore, the methods of measurement and determination of quantities shall strictly adhere to IS 1200.
- IS 1200 has 28 parts – one for each item of work. A list of all parts is given herewith.

Parts of IS 1200

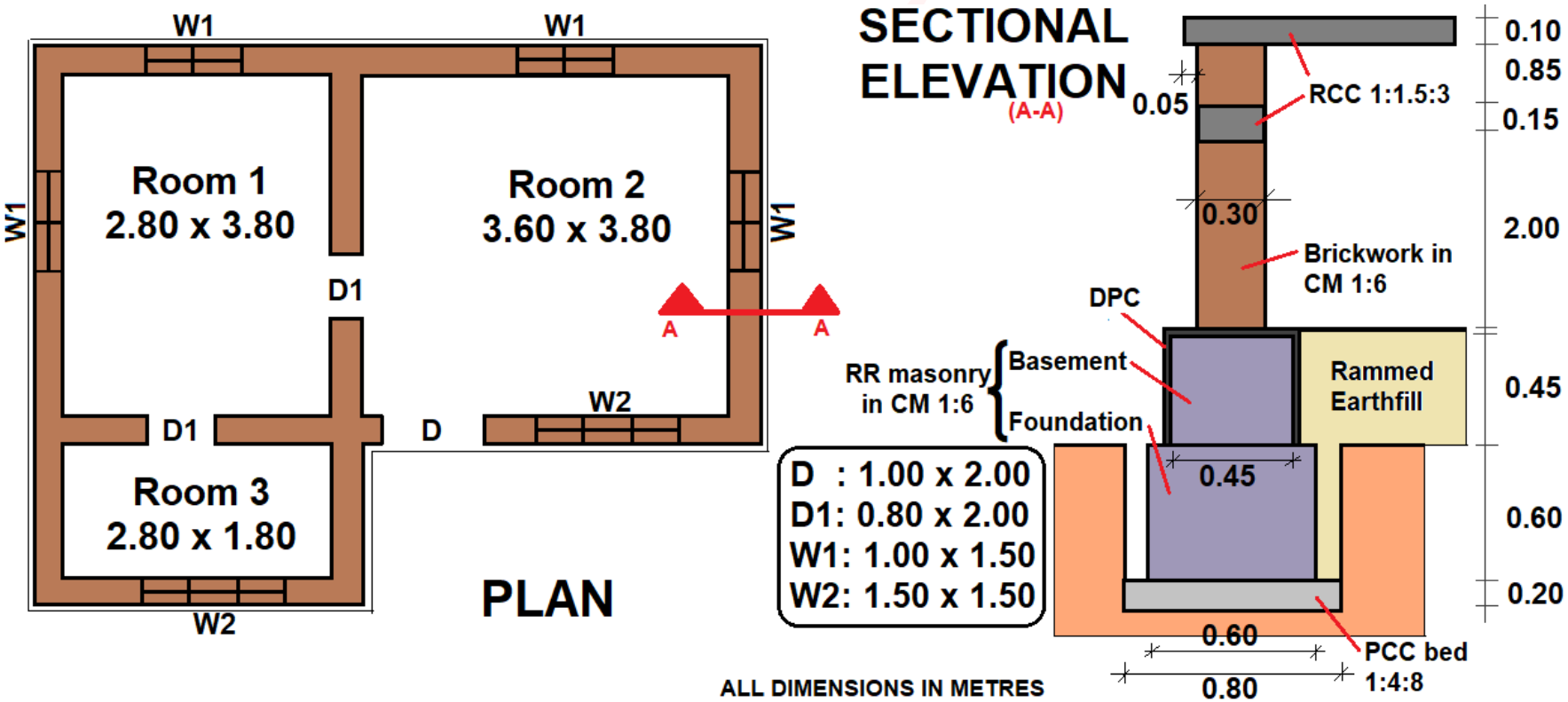
- Part 1: Earthwork
- Part 2: Concrete works
- Part 3: Brickwork
- Part 4: stone masonry
- Part 5: Form work
- Part 6: Refractory work
- Part 7: Hardware
- Part 8: Steel work and iron work
- Part 9: Roof covering (including cladding)
- Part 10: Ceiling and linings
- Part 11: Paving, floor finishes dado and skirting
- Part 12: Plastering and Pointing
- Part 13: Whitewashing, colour washing, distempering and painting of building surfaces
- Part 14: Glazing

Parts of IS 1200

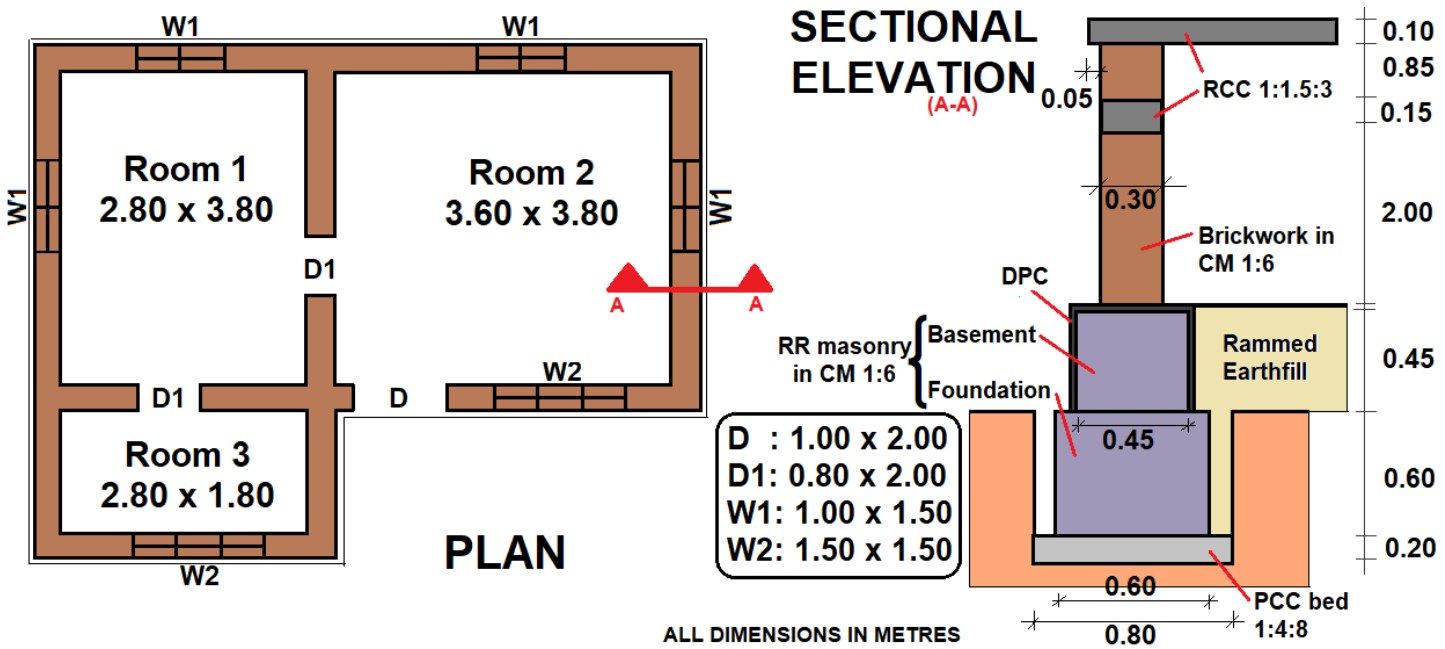
- Part 15: painting, polishing, varnishing etc
- Part 16: laying of water and sewer lines including appurtenant items
- Part 18: demolition and dismantling
- Part 19: Water Supply, Plumbing and Drains
- Part 20: laying of gas and oil pipelines
- Part 21: wood-work and joinery
- Part 22: materials
- Part 23: piling
- Part 24: well foundations
- Part 25: tunneling
- Part 26: Acid resistant lining
- Part 27: Earthwork done by mechanical appliances
- Part 28: Sound insulation works

Items & its Units

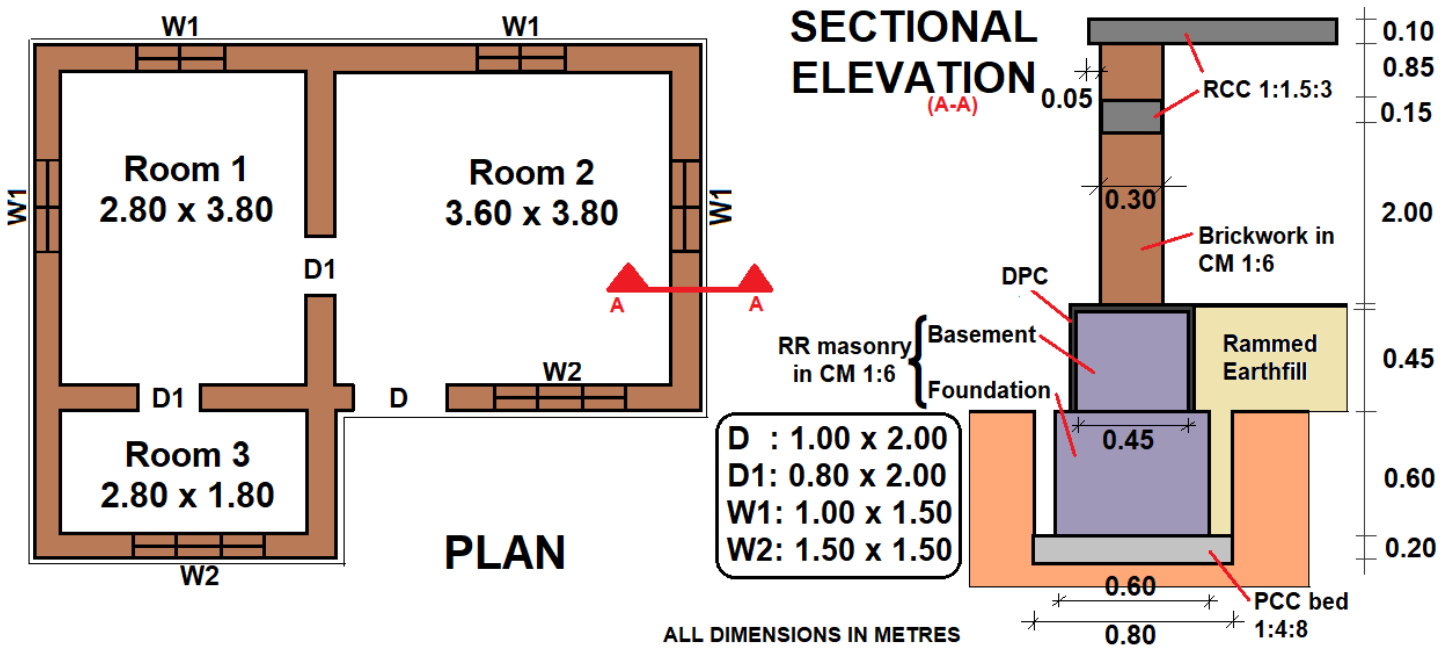
Consider the following plan of a proposed building (a load bearing structure). Study the figure carefully. Identify all relevant items of work and units of measurement.



Items & its Units

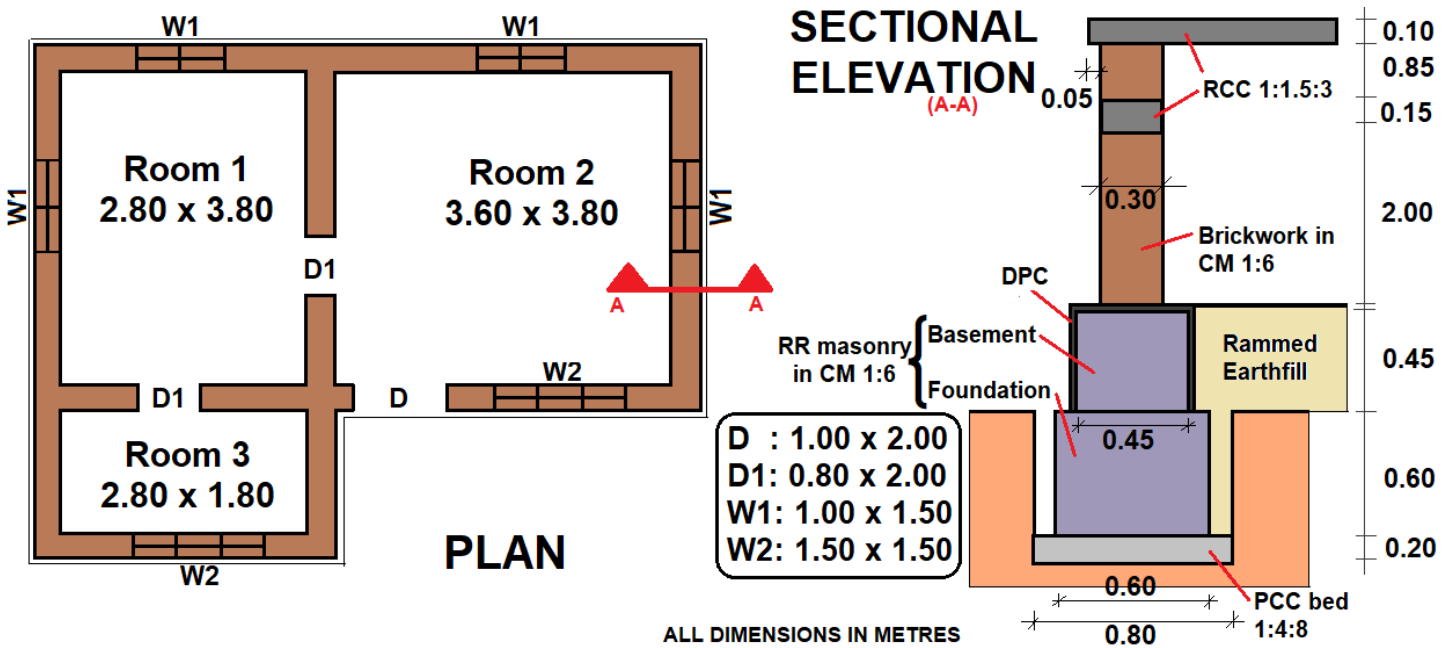


Items & its Units



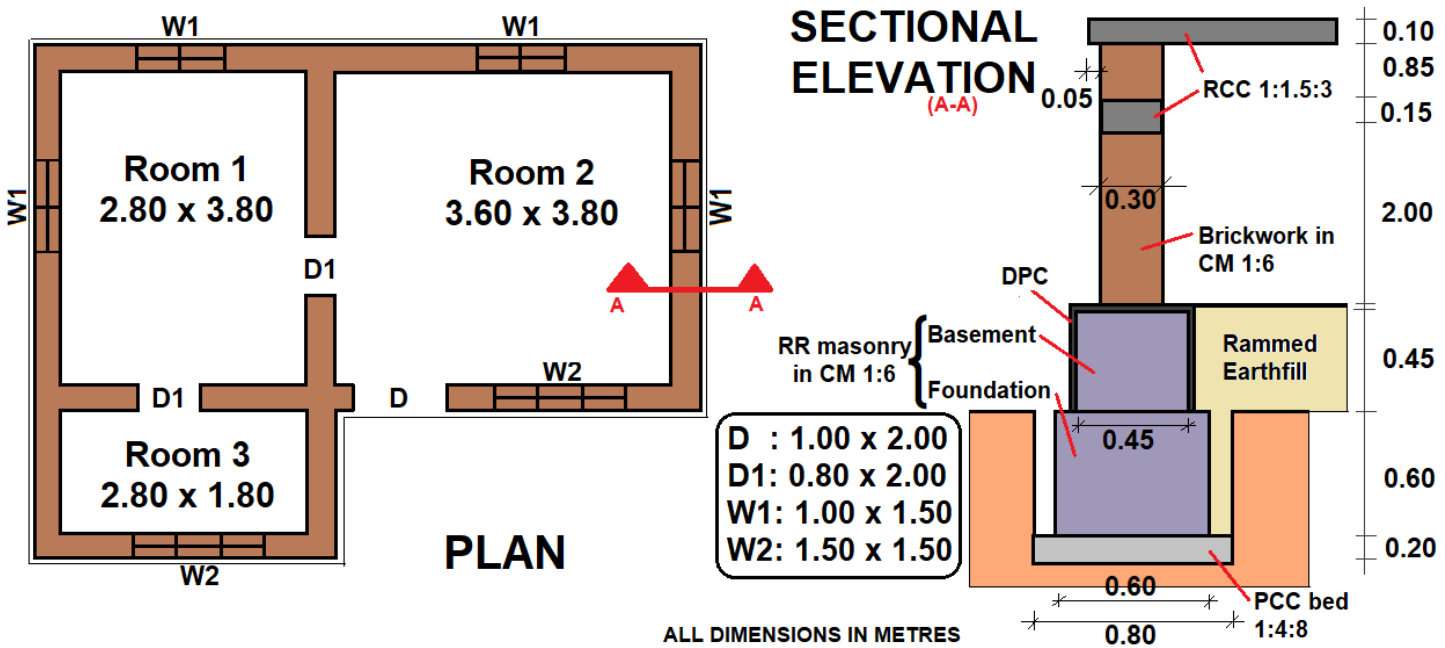
1. Earthwork in excavation (m^3)

Items & its Units



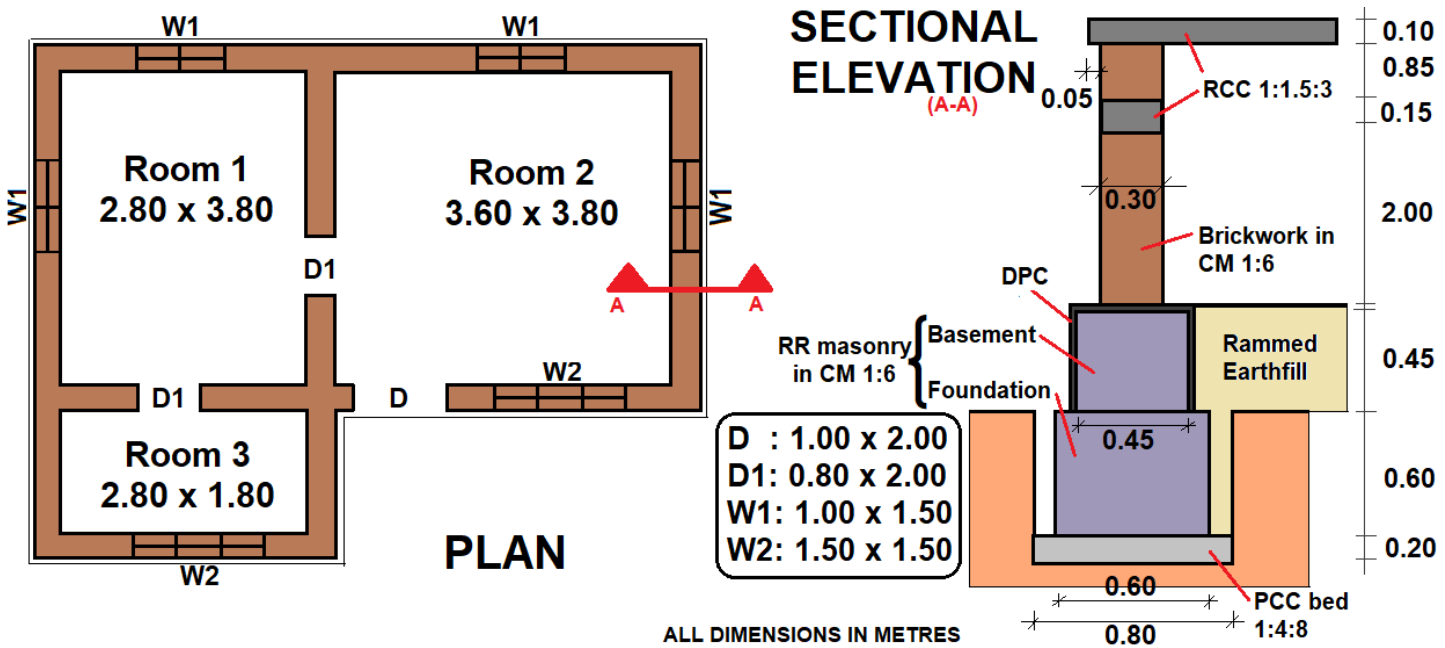
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)

Items & its Units



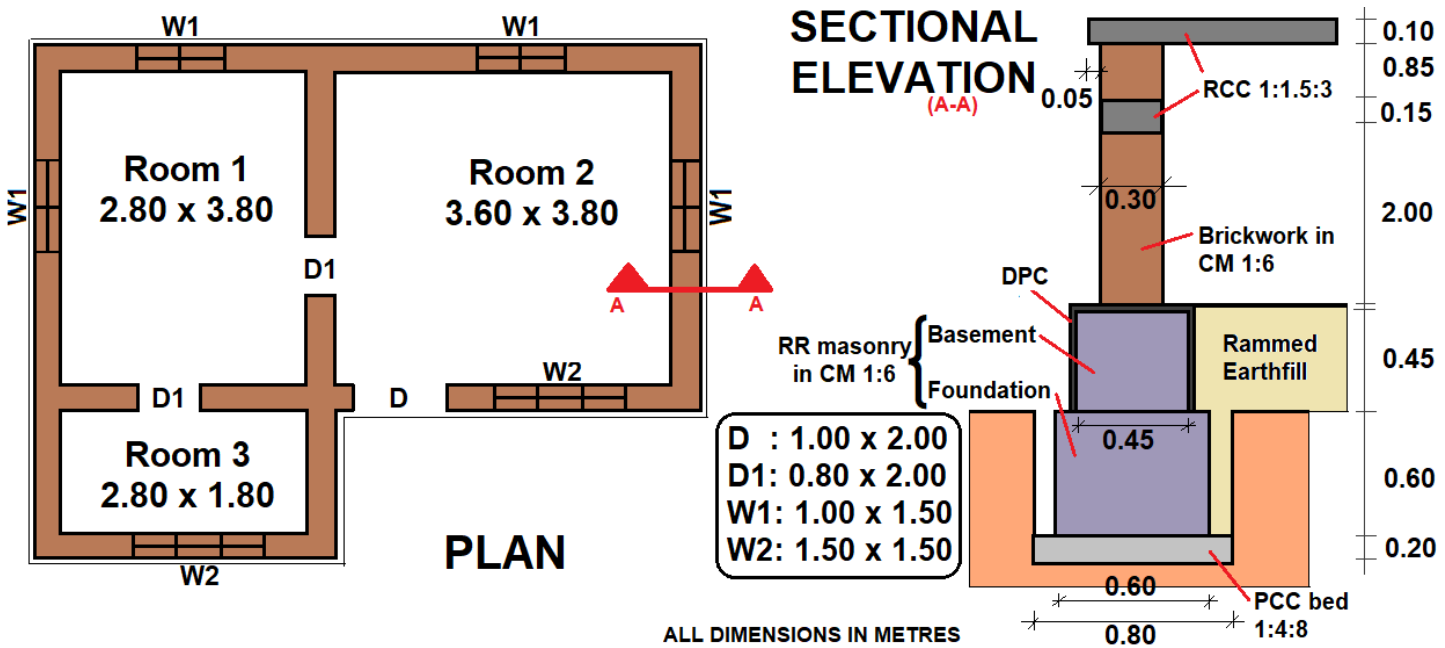
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)

Items & its Units



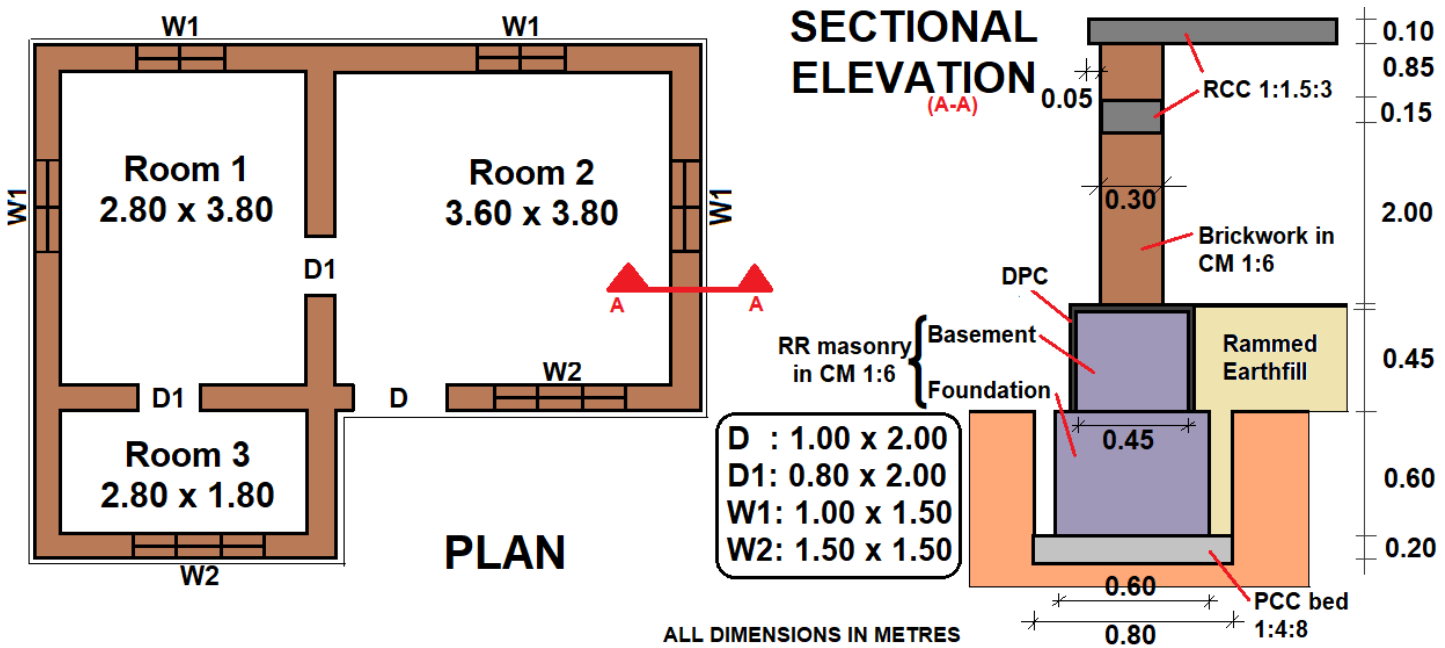
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)

Items & its Units



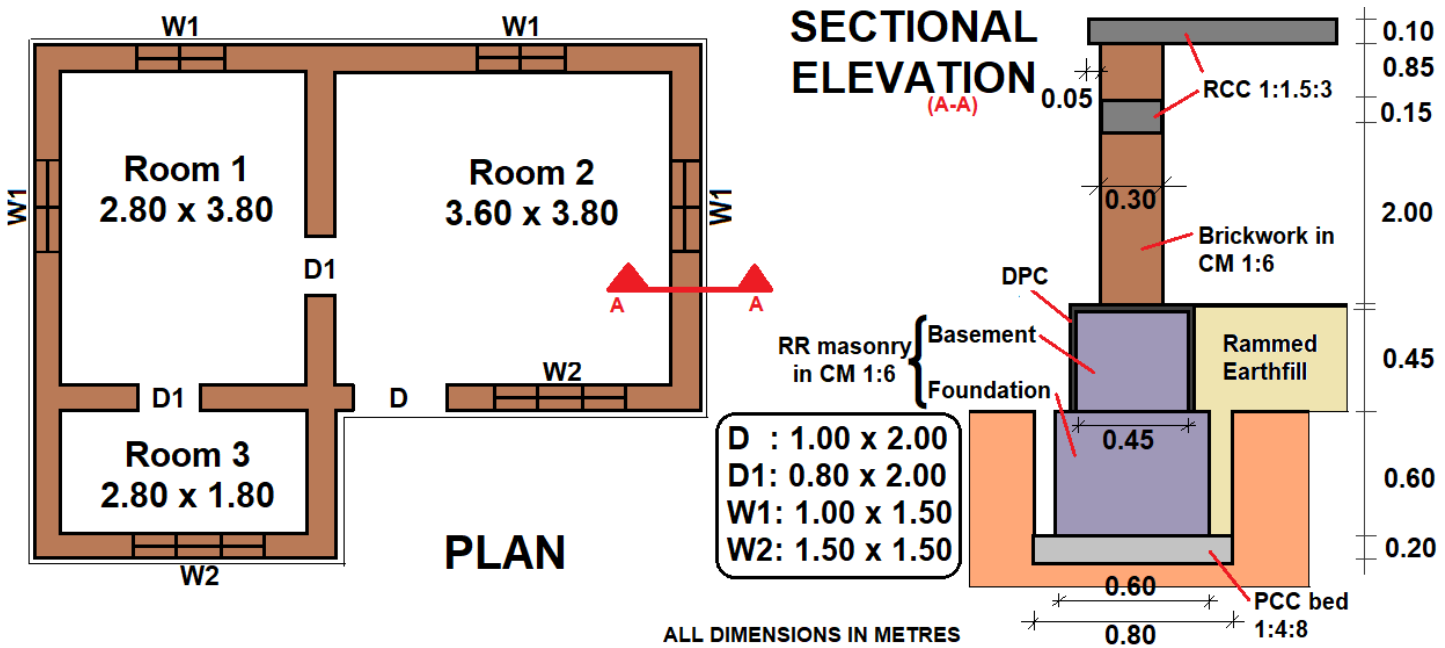
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)

Items & its Units



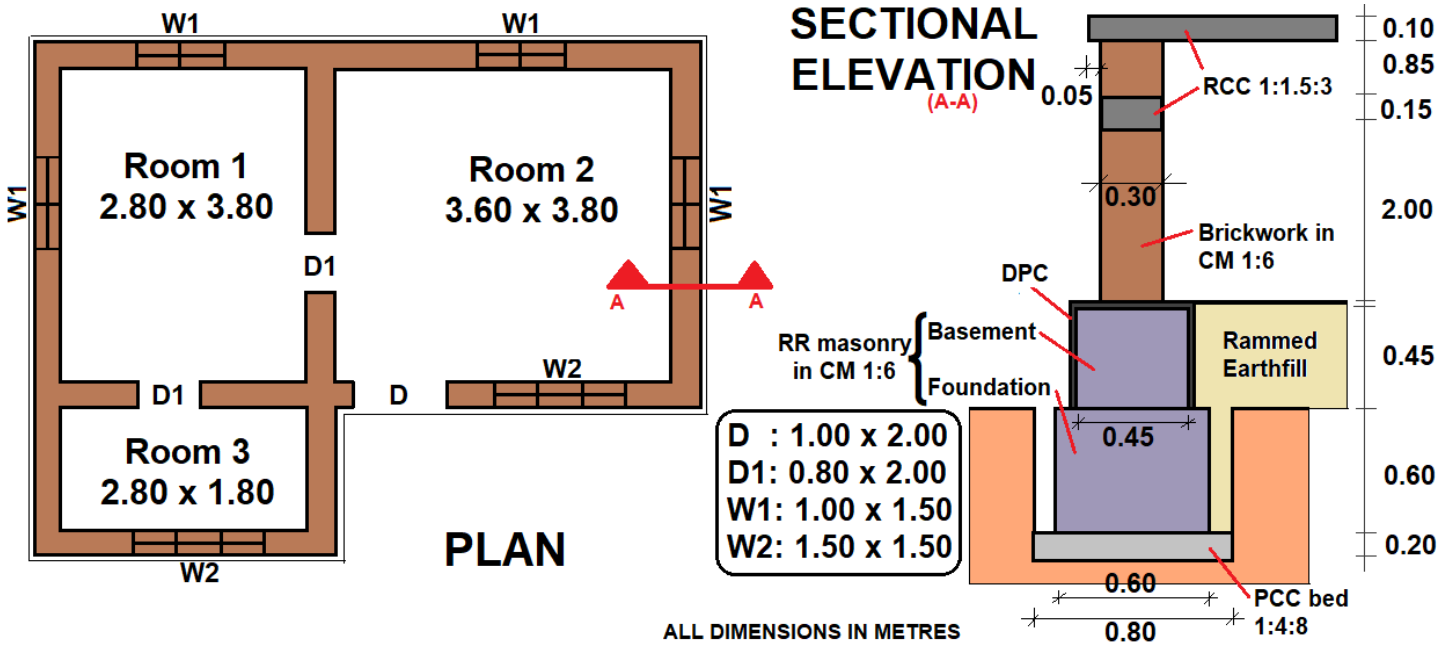
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)

Items & its Units



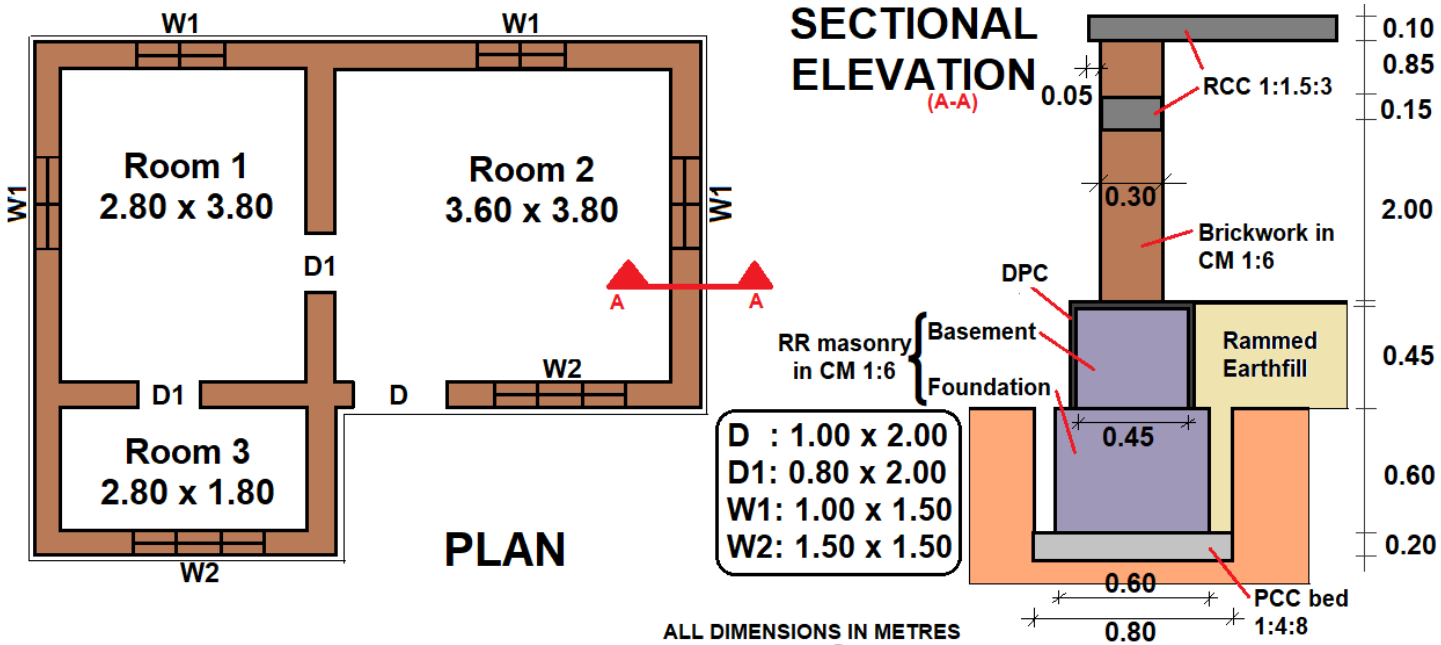
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)

Items & its Units



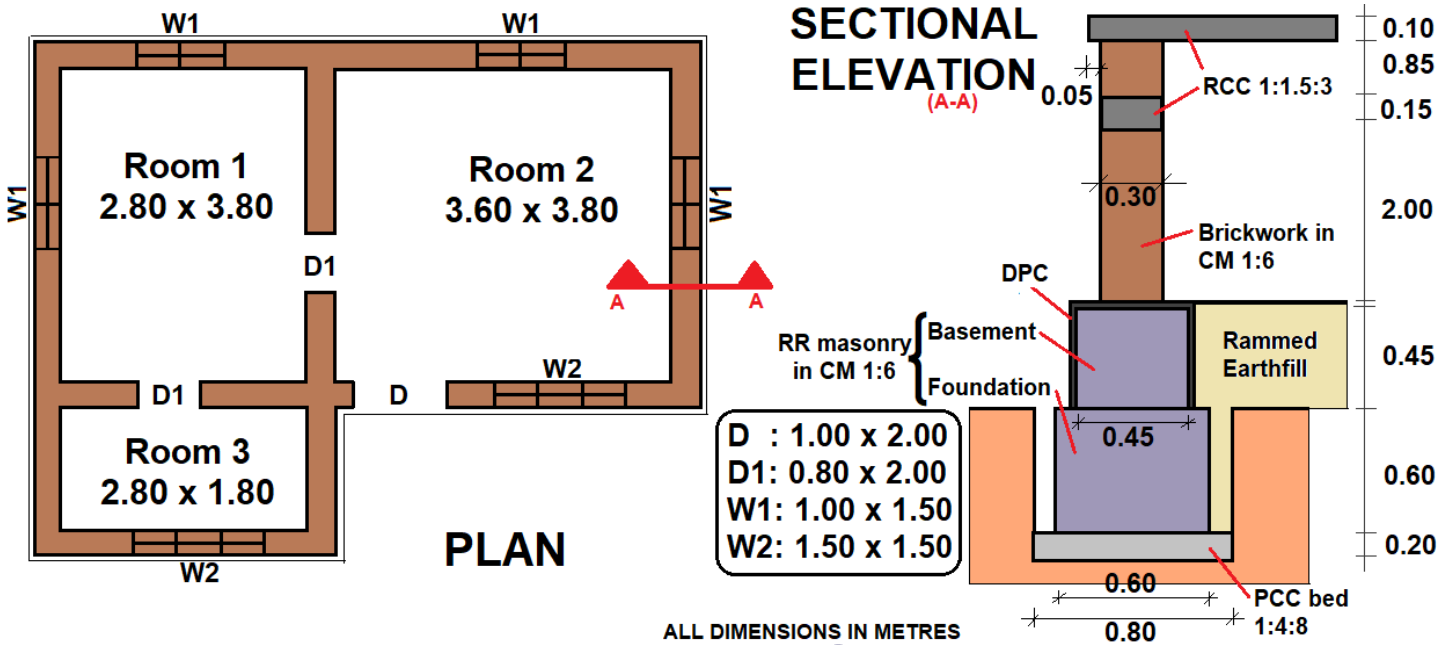
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)

Items & its Units



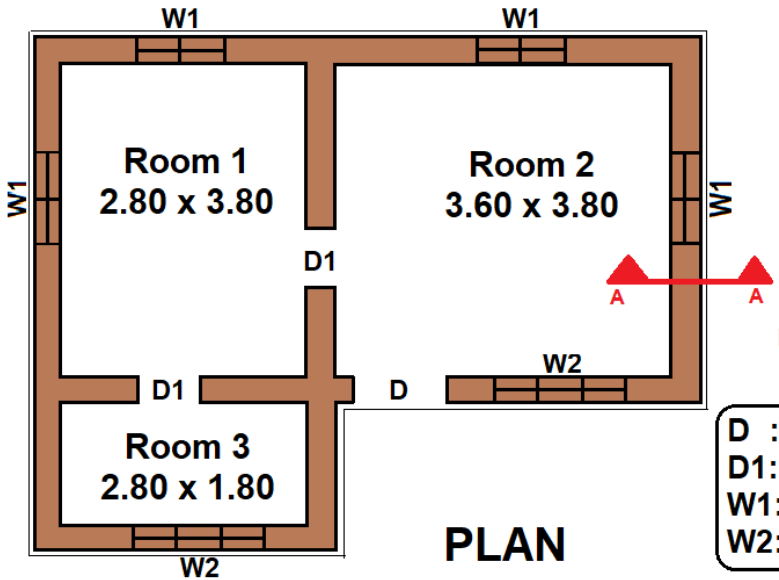
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)

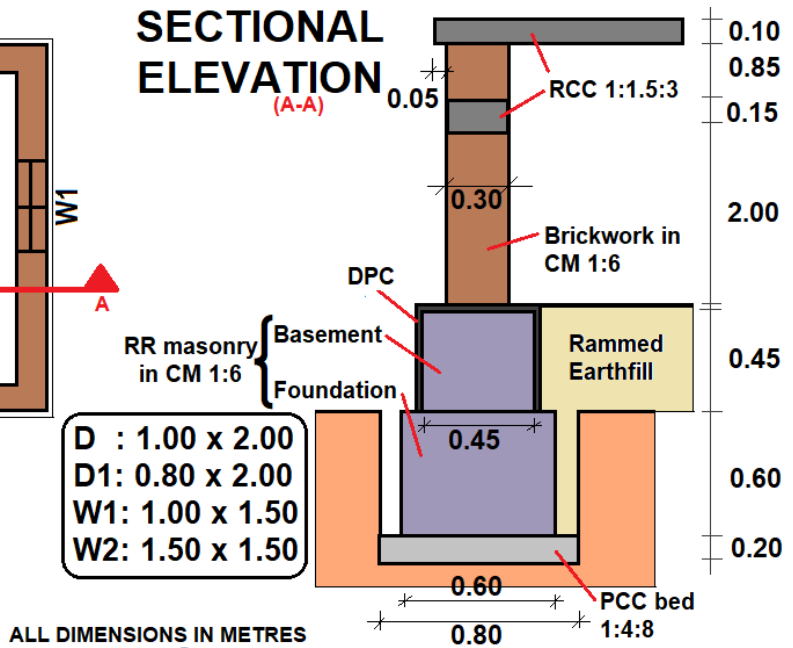
Items & its Units



1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)

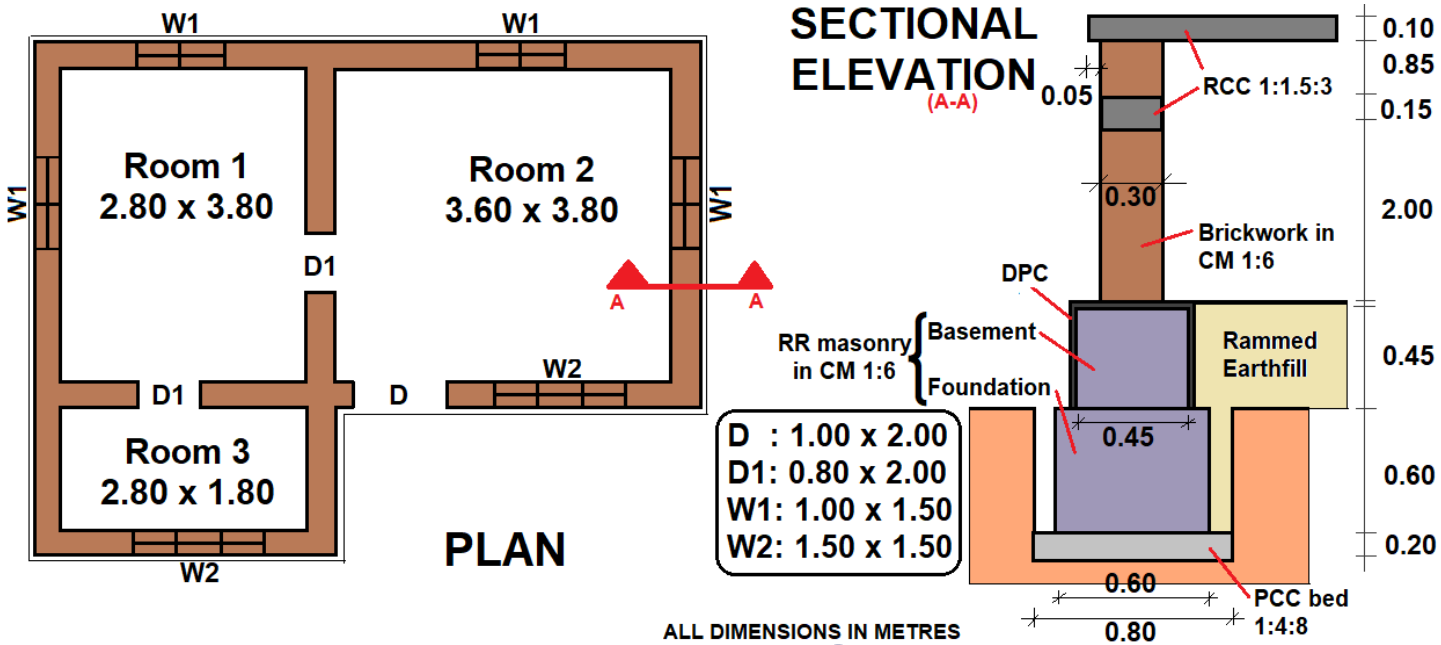
Items & its Units





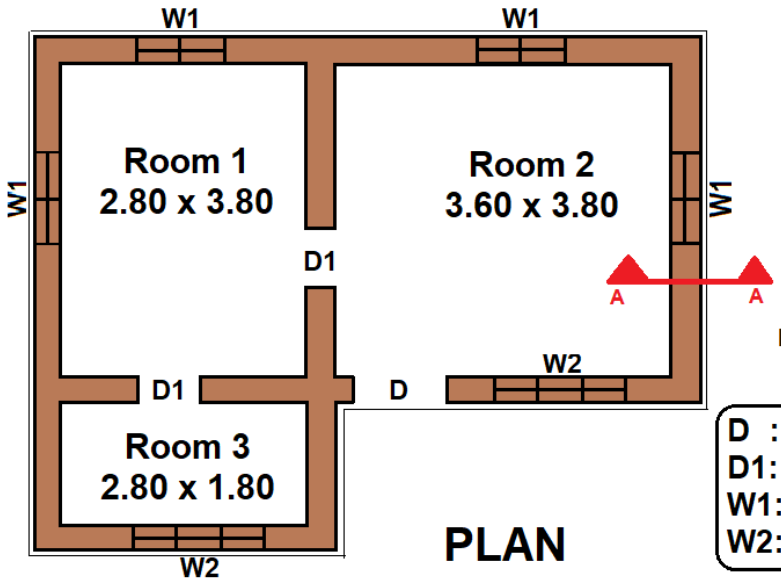
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)
11. PCC 1:2:4 on floors (m^3)

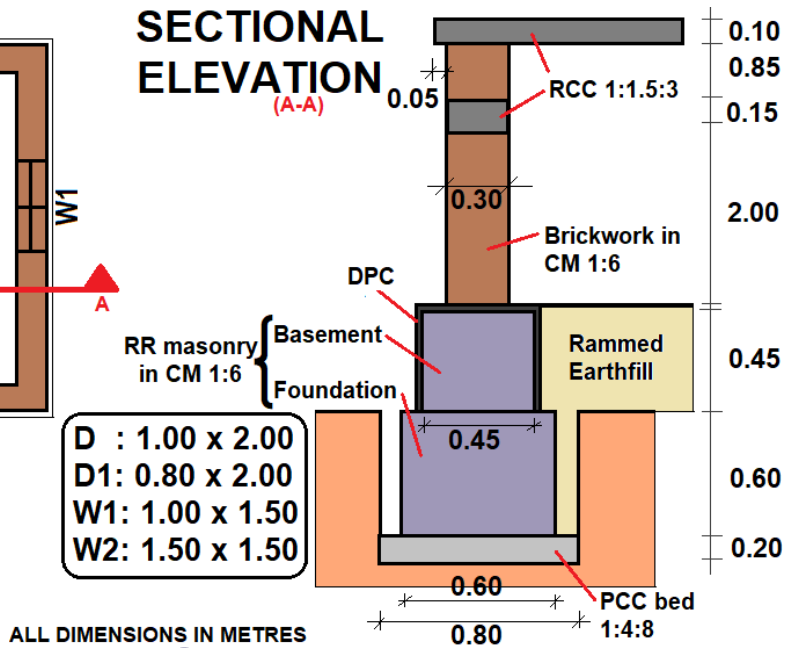
Items & its Units



1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)
11. PCC 1:2:4 on floors (m^3)
12. Flooring (tiles etc.) (m^2)

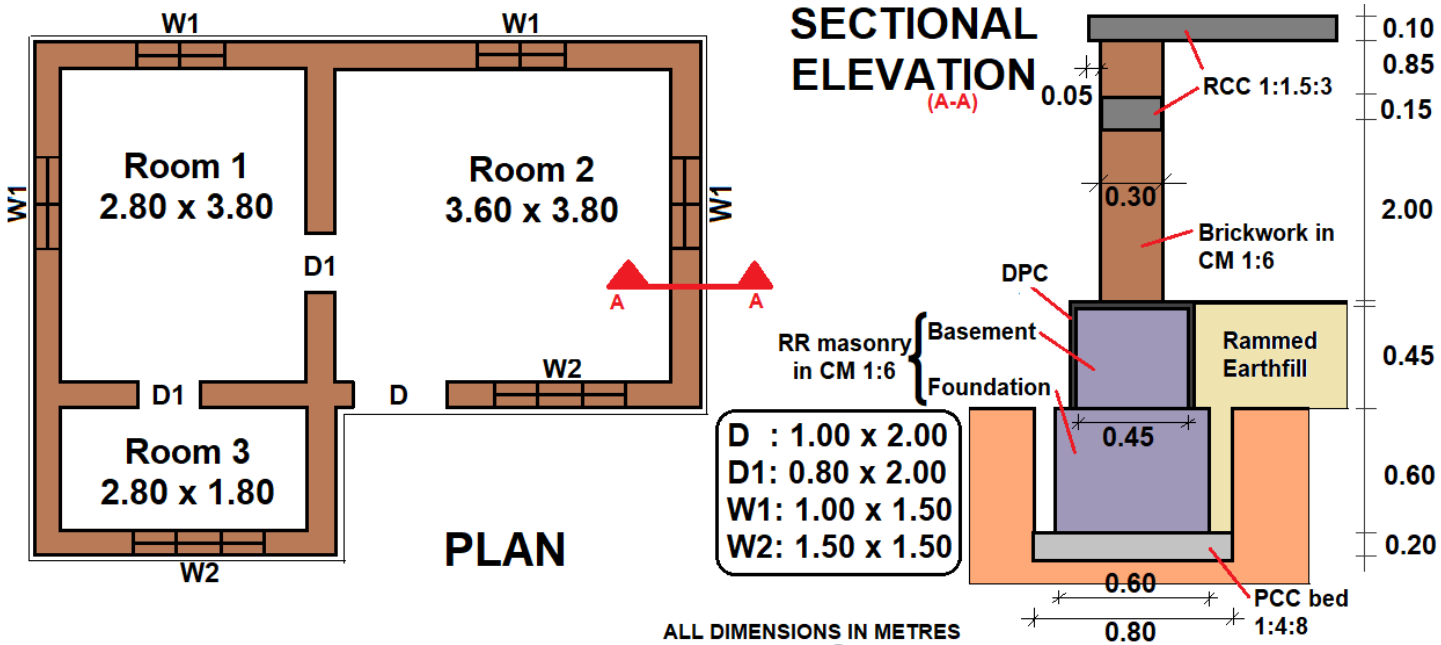
Items & its Units





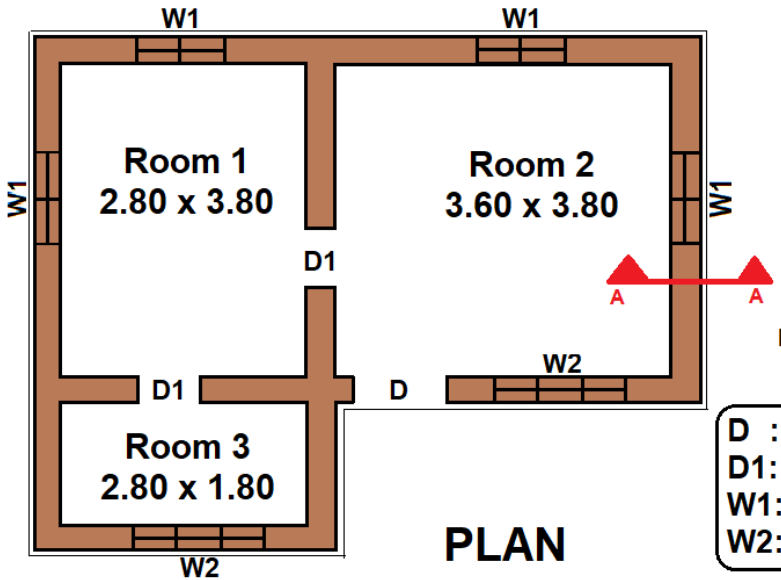
1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)
11. PCC 1:2:4 on floors (m^3)
12. Flooring (tiles etc.) (m^2)
13. Woodwork in frames of Doors, Windows, etc. (m^3)

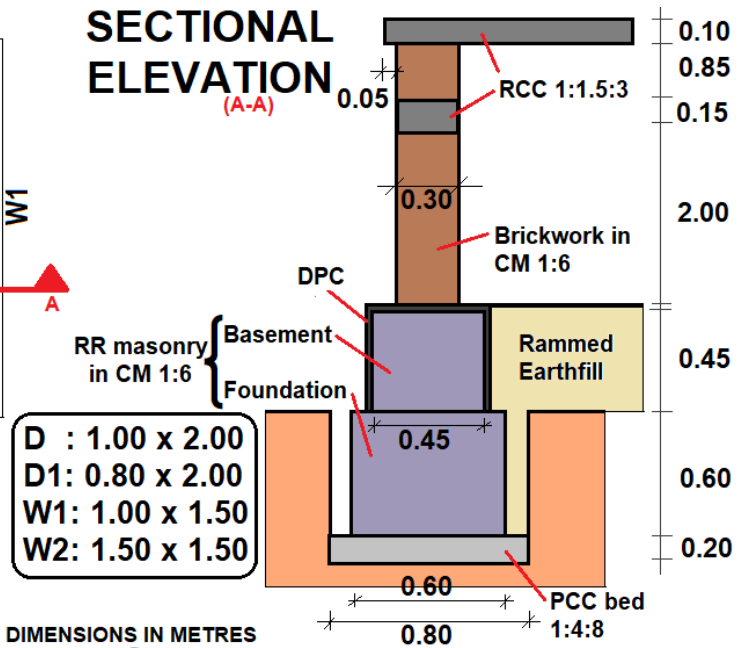
Items & its Units



1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)
11. PCC 1:2:4 on floors (m^3)
12. Flooring (tiles etc.) (m^2)
13. Woodwork in frames of Doors, Windows, etc. (m^3)
14. White washing / Cement Primer / Emulsion paints on walls (m^2)

Items & its Units

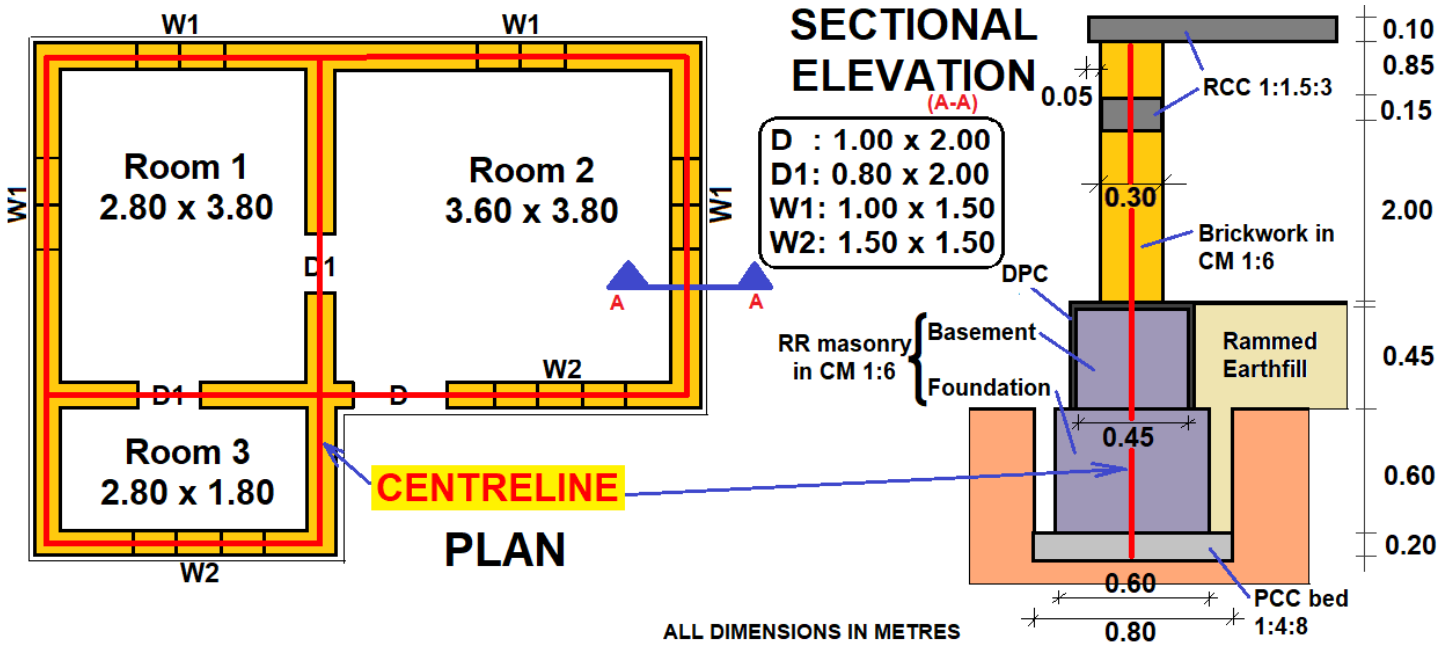




1. Earthwork in excavation (m^3)
2. PCC 1:4:8 in foundation (m^3)
3. RR masonry in CM 1:6 in foundation and basement (m^3)
4. Damp-proof Course (m^2)
5. Brickmasonry in CM 1:6 (m^3)
6. Centering & Shuttering for RCC works (m^2)
7. TMT bars (Fe500 grade) (kg)
8. RCC 1:1.5:3 (m^3)
9. Cement Plaster 12mm thick on walls (m^2)
10. Cement Plaster 6mm thick on ceiling (m^2)
11. PCC 1:2:4 on floors (m^3)
12. Flooring (tiles etc.) (m^2)
13. Woodwork in frames of Doors, Windows, etc. (m^3)
14. White washing / Cement Primer / Emulsion paints on walls (m^2)
15. Priming coat / Synthetic Enamel Paint on woodwork (m^2)

Etc.....

Items & its Units

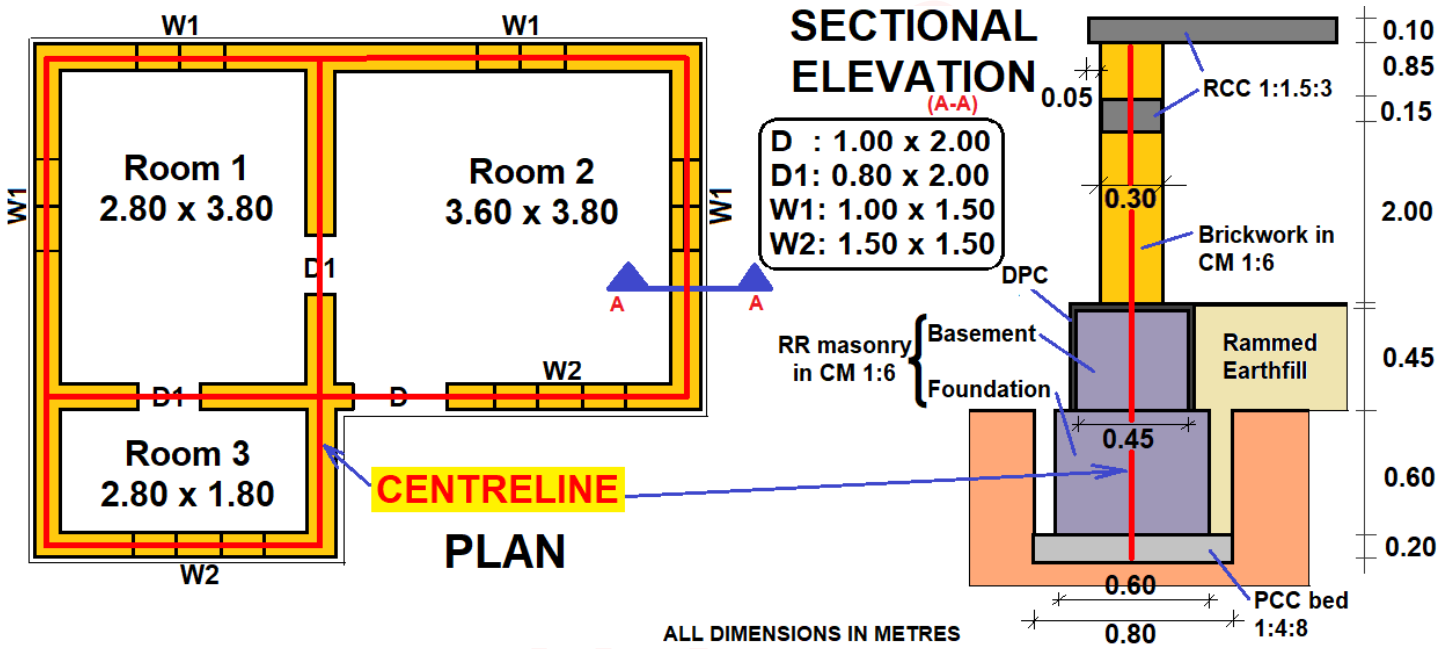


Note that the following items of work are distributed along the Centreline of walls of the building.

This is because, the building is a load bearing structure.

1. Earthwork in excavation
2. PCC 1:4:8 in foundation
3. RR masonry in CM 1:6 in foundation and basement.
4. Damp-proof Course
5. Brickmasonry in CM 1:6
6. RCC 1:1.5:3 in Lintel band

Items & its Units



Such items of work, which are **distributed** along the **Centreline of walls** of a **Load-bearing Structure**, can be quantified by any on the following methods:

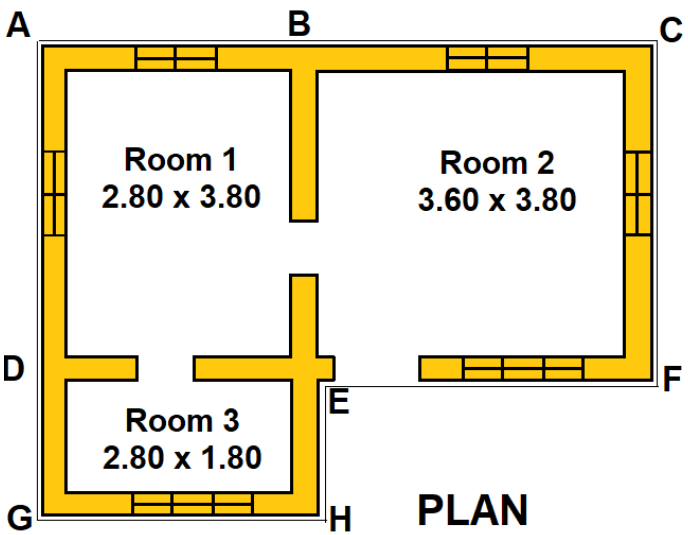
1. Long wall–Short wall method
2. Centreline method

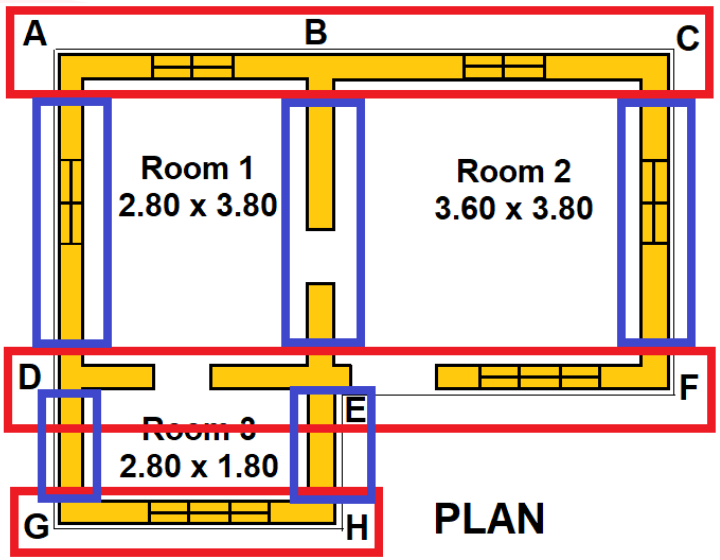
Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

Definition:

This method identifies the walls of the building as Long Walls & Short Walls, such that:

- **Long Walls** refer to all walls of that building in a single direction, and are predominantly longer;
- **Short Walls** refer to all other walls of that building, which are perpendicular to the direction of Long Walls.



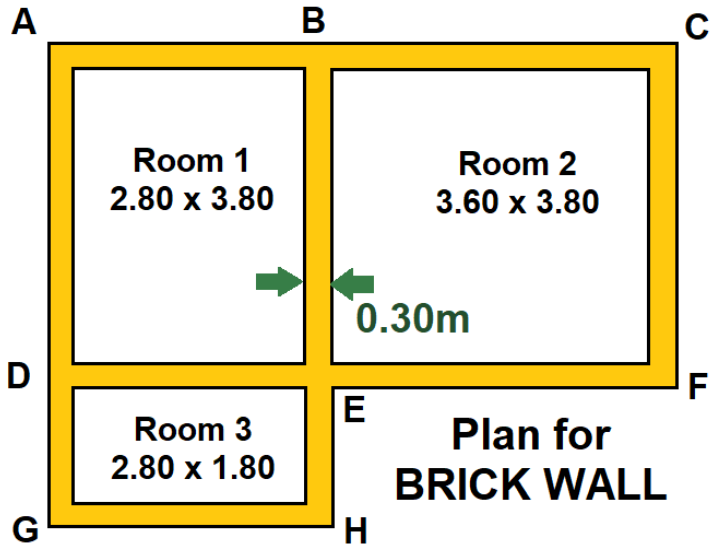


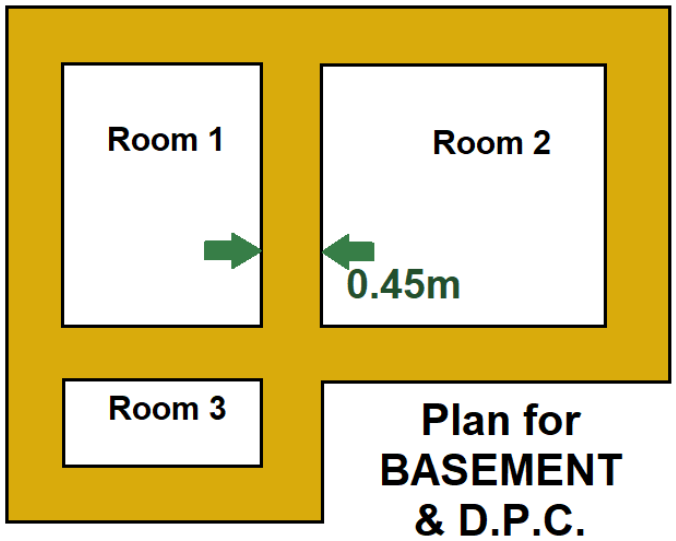
Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

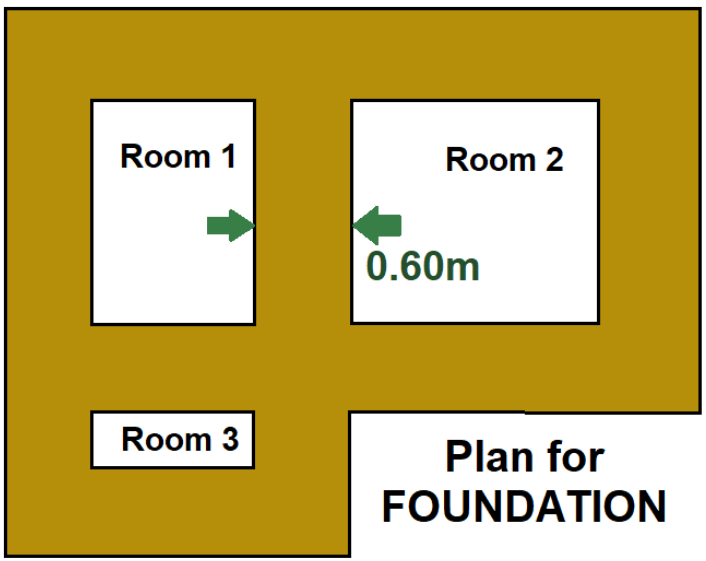
Definition (Contd..):

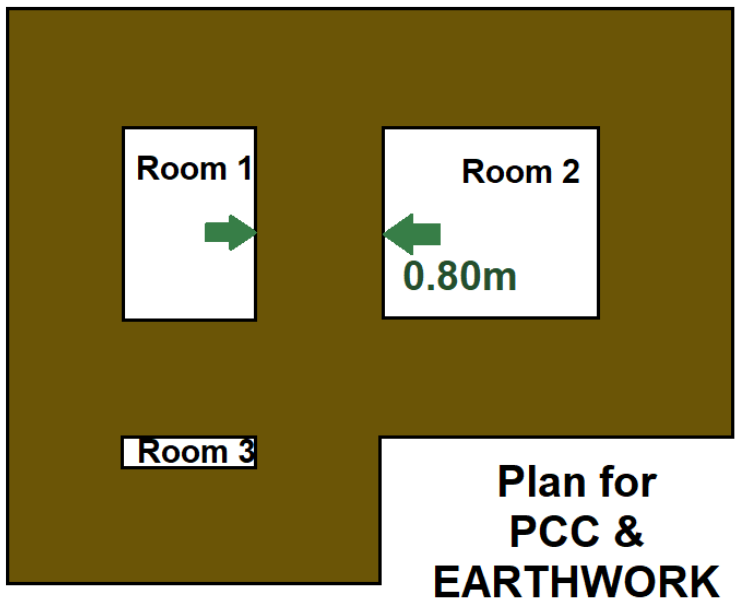
- Here the term "**wall**" refers to the legs/sides of any the **following items** and not just by its literal meaning.
  1. Earthwork in excavation
  2. PCC 1:4:8 in foundation
  3. RR masonry in CM 1:6 in foundation and basement.
  4. Damp-proof Course
  5. Brickmasonry in CM 1:6
  6. RCC 1:1.5:3 in Lintel band
- This is because, all these items have **same shape in plan**, but **differ** only in their **width** (see next slide).

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")







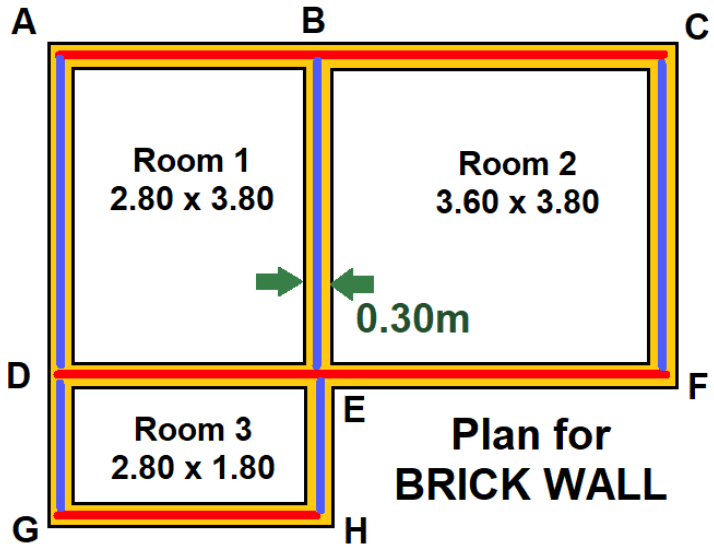


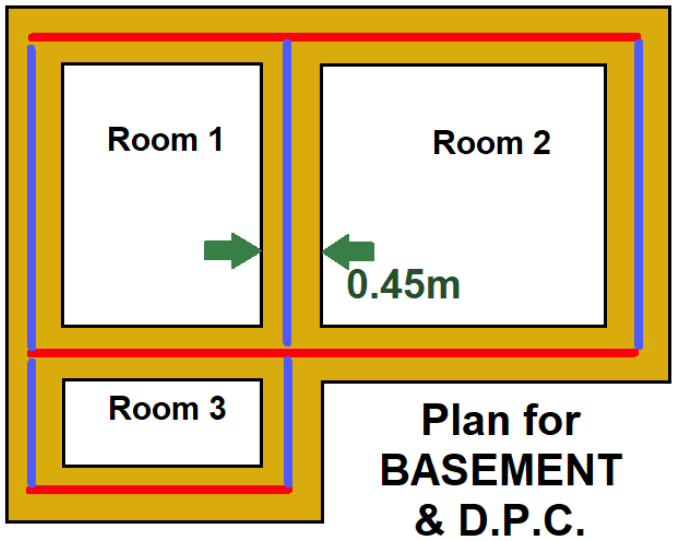
Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

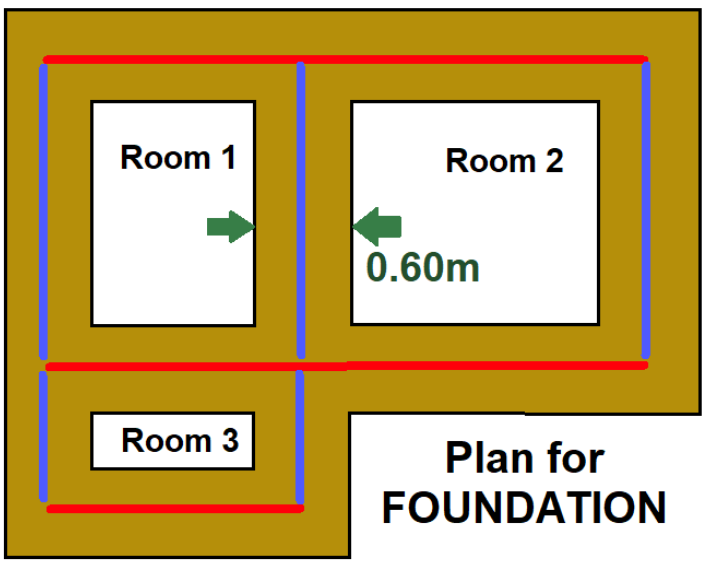
Definition (Contd..):

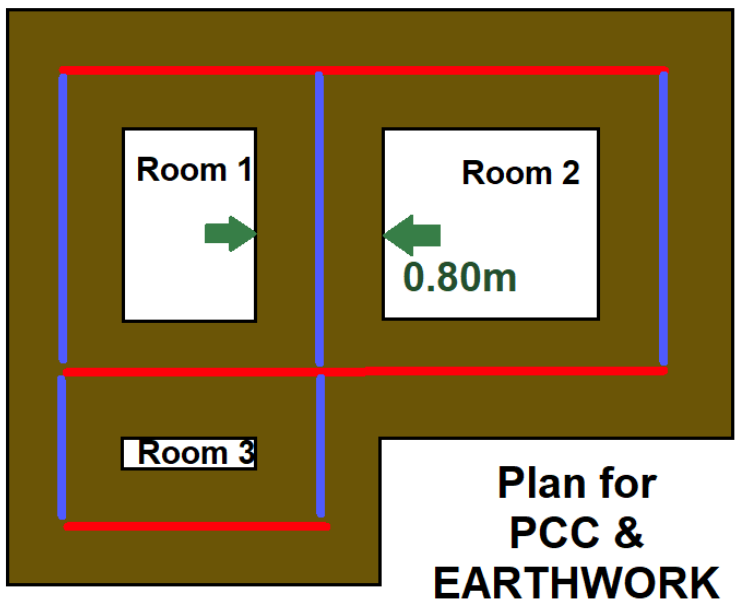
- Also note that, all these items have the **same Centreline length**, irrespective of their difference in width (see next slide).

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")





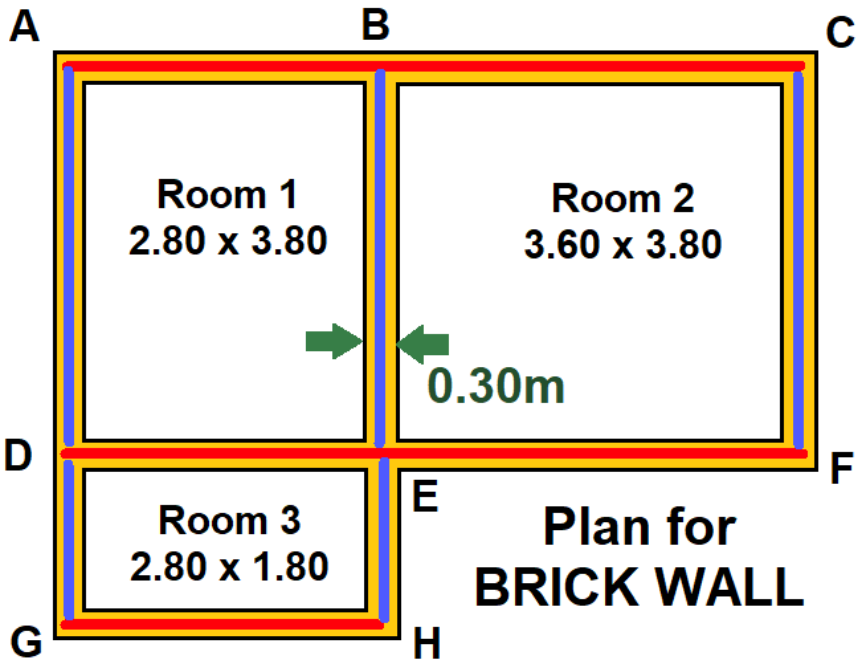




Centreline of Longwalls Centreline of Shortwalls

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

- Since the length of Centrelines of all these items are same, it shall suffice to compute its magnitude from the **Plan of BRICKWALL** as shown here.



Centreline length of:

(a) Long Walls

ABC = 2.80 + 0.30 + 3.60 + 0.30 = 7.00m

DEF = ABC = 7.00m

GH = 2.80 + 0.30 = 3.10m

(b) Short Walls

AD = BE = CF = 3.80 + 0.30 = 4.10m

DG = EH = 1.80 + 0.30 = 2.10m

- Therefore, the **Centreline length of Longwall and Shortwall** for other items – Earthwork, PCC, RR masonry, DPC and Lintel band RCC – is the same as computed above.

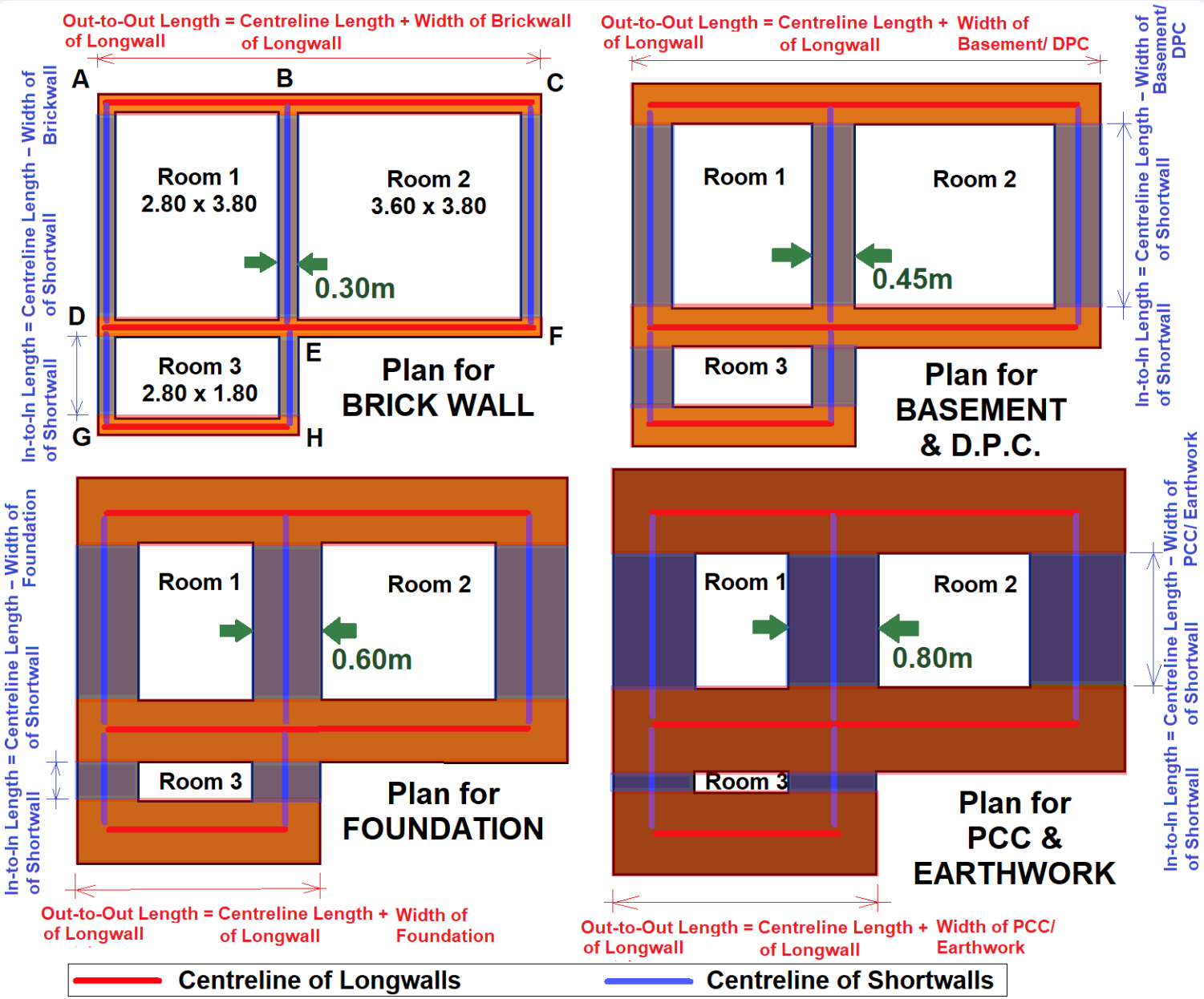
Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

Definition (Contd..):

- Long Walls are expressed in terms of its **out-to-out length**;
- Short Walls are expressed in terms of its **in-to-in length**.

(See next slide)

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")



Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

Therefore, the Out-to-out Length of Long walls and the In-to-in Length of short walls for each of the item may be computed as follows:

1. **Earthwork in excavation** and **PCC 1:4:8 in foundation:**

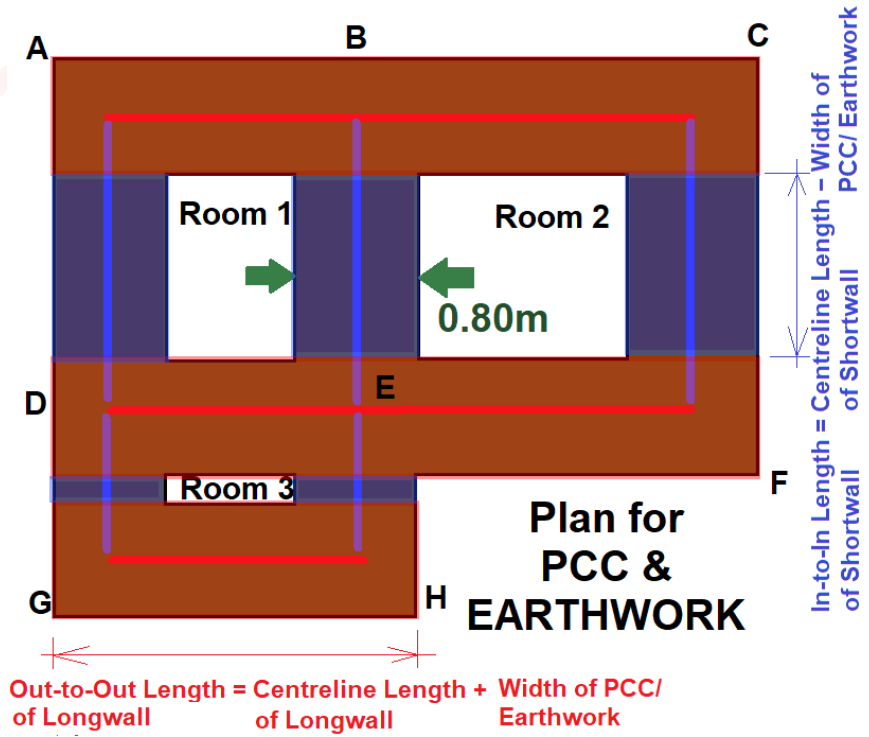
Longwalls:

- ABC: 7.00 + 0.80 = 7.80m
- DEF: 7.00 + 0.80 = 7.80m
- GH: 3.10 + 0.80 = 3.90m
  Total = **19.50m**

Shortwalls:

- AD: 4.10 - 0.80 = 3.30m
- BE: 4.10 - 0.80 = 3.30m
- CF: 4.10 - 0.80 = 3.30m
- DG: 2.10 - 0.80 = 1.30m
- EH: 2.10 - 0.80 = 1.30m
  Total = **12.50m**

Total Length = 32.00m



Centreline Length of:
ABC = DEF = 7.00m
GH = 3.10m
AD = BE = CF = 4.10m
DG = EH = 2.10m

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

2. **RR masonry in CM 1:6 in foundation:**

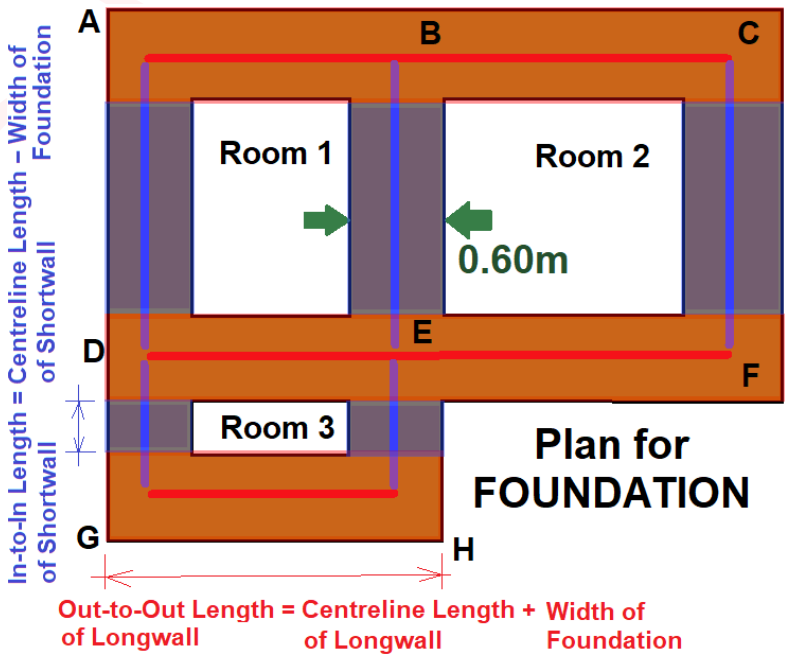
Longwalls:

- ABC: 7.00 + 0.60 = 7.60m
- DEF: 7.00 + 0.60 = 7.60m
- GH: 3.10 + 0.60 = 3.70m
  Total = **18.90m**

Shortwalls:

- AD: 4.10 - 0.60 = 3.50m
- BE: 4.10 - 0.60 = 3.50m
- CF: 4.10 - 0.60 = 3.50m
- DG: 2.10 - 0.60 = 1.50m
- EH: 2.10 - 0.60 = 1.50m
  Total = **13.50m**

Total Length = 32.40m



Centreline Length of:
ABC = DEF = 7.00m
GH = 3.10m
AD = BE = CF = 4.10m
DG = EH = 2.10m

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

3. **RR masonry in CM 1:6 in Basement** and **Damp-proof Course:**

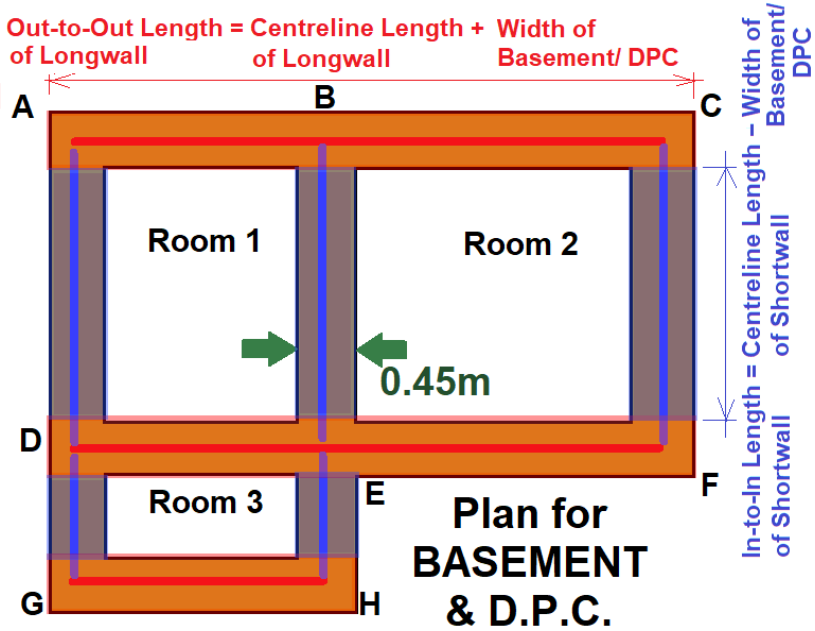
Longwalls:

- ABC: 7.00 + 0.45 = 7.45m
- DEF: 7.00 + 0.45 = 7.45m
- GH: 3.10 + 0.45 = 3.55m
  Total = **18.45m**

Shortwalls:

- AD: 4.10 - 0.45 = 3.65m
- BE: 4.10 - 0.45 = 3.65m
- CF: 4.10 - 0.45 = 3.65m
- DG: 2.10 - 0.45 = 1.65m
- EH: 2.10 - 0.45 = 1.65m
  Total = **14.25m**

Total Length = 32.70m



Centreline Length of:
ABC = DEF = 7.00m
GH = 3.10m
AD = BE = CF = 4.10m
DG = EH = 2.10m

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

4. **Brick masonry in CM 1:6** and **RCC 1:1.5:3 in Lintel band:**

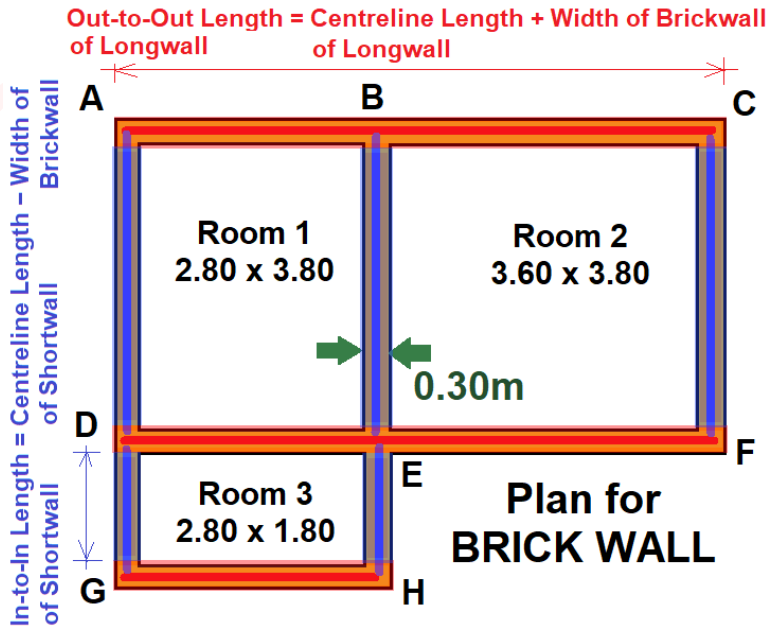
Longwalls:

- ABC: 7.00 + 0.30 = 7.30m
- DEF: 7.00 + 0.30 = 7.30m
- GH: 3.10 + 0.30 = 3.40m
  Total = **18.00m**

Shortwalls:

- AD: 4.10 - 0.30 = 3.80m
- BE: 4.10 - 0.30 = 3.80m
- CF: 4.10 - 0.30 = 3.80m
- DG: 2.10 - 0.30 = 1.80m
- EH: 2.10 - 0.30 = 1.80m
  Total = **15.00m**

Total Length = 33.00m



Centreline Length of:
ABC = DEF = 7.00m
GH = 3.10m
AD = BE = CF = 4.10m
DG = EH = 2.10m

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

The Items thus quantified are tabulated as follows:

Sl. No.	Details of Item	No.	L (m)	B (m)	H (m)	Quantity
1	Earthwork in excavation	1	32.00	0.80	0.80	$20.48m^3$
2	PCC 1:4:8 in foundation	1	32.00	0.80	0.20	$5.12m^3$
3	RR masonry in CM 1:6 in					
	(a) foundation	1	32.40	0.60	0.60	$11.66m^3$
	(b) basement	1	32.70	0.45	0.45	$\underline{6.62m^3}$
	Total					$18.28m^3$
4	D.P.C B=0.45+0.45+0.45=1.35m	1	32.70	1.35		$44.15m^2$

Long wall–Short wall Method (or "**Out-to-out** & **In-to-in Method**")

Sl. No.	Details of Item	No.	L (m)	B (m)	H (m)	Quantity
5	Brickmasonry in CM 1:6 H=2.00+0.85=2.85m **Deductions:**	1	33.00	0.30	2.85	$28.22m^3$
	D	1	1.00	0.30	2.00	-$0.60m^3$
	D1	2	0.80	0.30	2.00	-$0.96m^3$
	W1	4	1.00	0.30	1.50	-$1.80m^3$
	W2	2	1.50	0.30	1.50	-$1.35m^3$
	Total					$23.51m^3$
6	RCC 1:1.5:3 in Lintel band	1	33.00	0.30	0.15	$1.49m^3$

Note: The Item No. 5 referred to as Brickmasonry in superstructure has few sub-items with negative quantities, to account for **wall openings** (such as Doors, Windows, Ventilators, etc.) and hence, whose volumes are duly deducted from the gross volume (computed without considering the effect of wall openings) of Brickwork.

Centreline Method

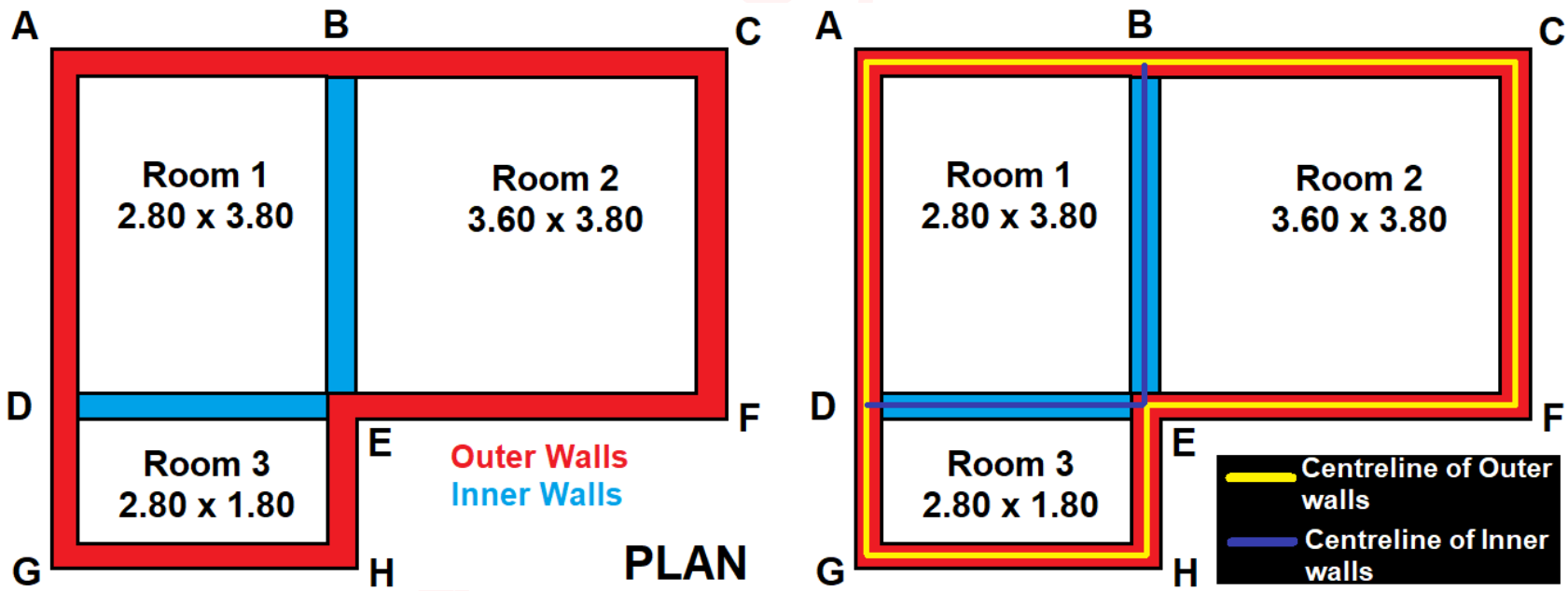
Definition:

- This method involves determination of **Centreline length of all walls** of a building.
- As in the previous method, this method also bases itself to the fact that the Centreline length of all the following items remain the **same**.
  1. Earthwork in excavation
  2. PCC 1:4:8 in foundation
  3. RR masonry in CM 1:6 in foundation and basement.
  4. Damp-proof Course
  5. Brickmasonry in CM 1:6
  6. RCC 1:1.5:3 in Lintel band

Centreline Method

Procedure:

1. Here, the walls of the building are identified as **Outer Walls** and **Inner Walls**.



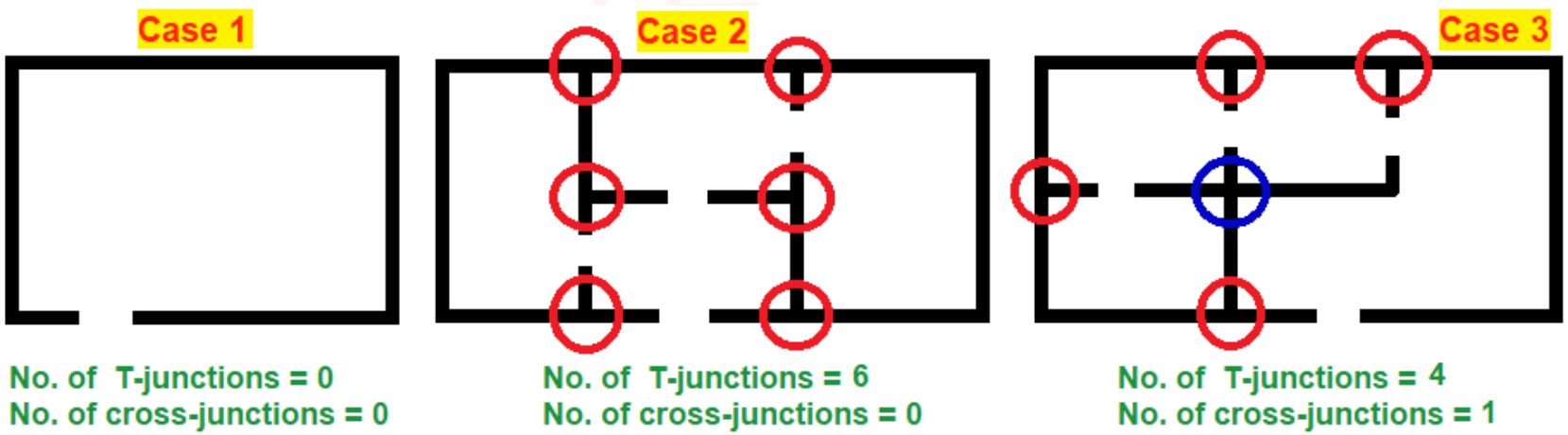
2. The **Centreline Length** of **Outer Walls** and **Inner Walls** are worked out separately, and thus obtained as say, $\mathbf{CL}_{outer}$ and $\mathbf{CL}_{inner}$ respectively.

Centreline Method

Procedure:

3. If **CL**$_{outer}$ and **CL**$_{inner}$ are known, then **Net Length of item** is computed as follows:

Case	Type of Building	Net Length of the Item
1	Single Roomed Building (with only **2-wall intersections**)	CL_{outer}+CL_{inner}
2	Building with 3-wall intersections (**T-junctions**)	CL_{outer}+CL_{inner} – (No. of T-junctions x $\frac{Width\ of\ Item}{2}$)
3	Building with 4-wall intersections (**cross-junctions**) in addition to **T-junctions**	CL_{outer}+CL_{inner} – (No. of T-junctions x $\frac{Width\ of\ Item}{2}$) – (No. of cross-junctions x Width of Item)



Centreline Method

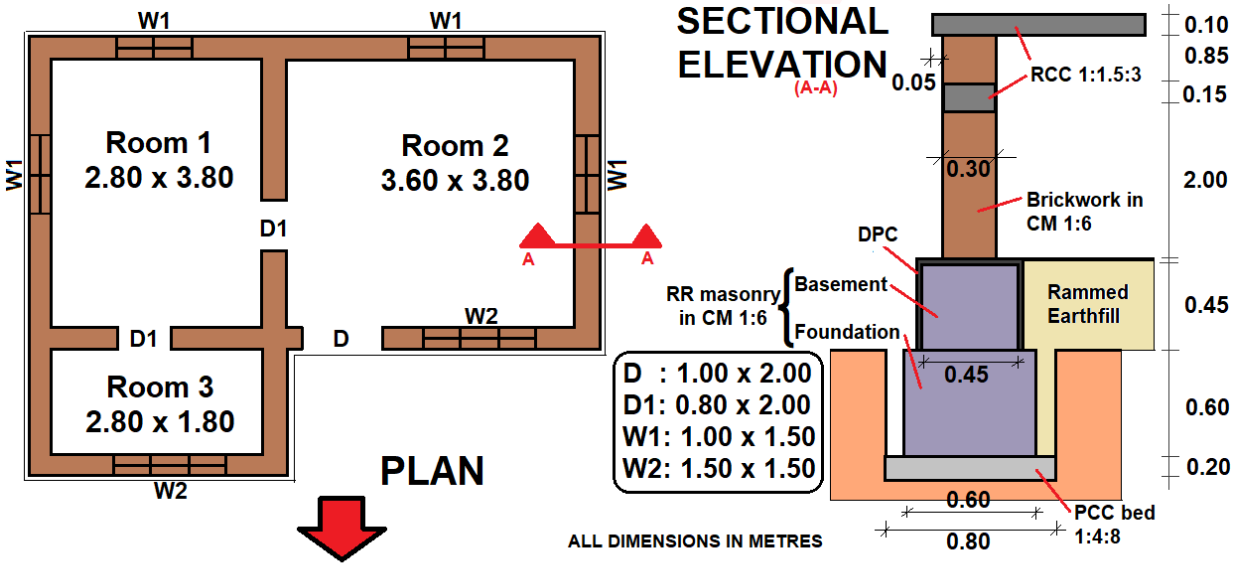
Procedure:

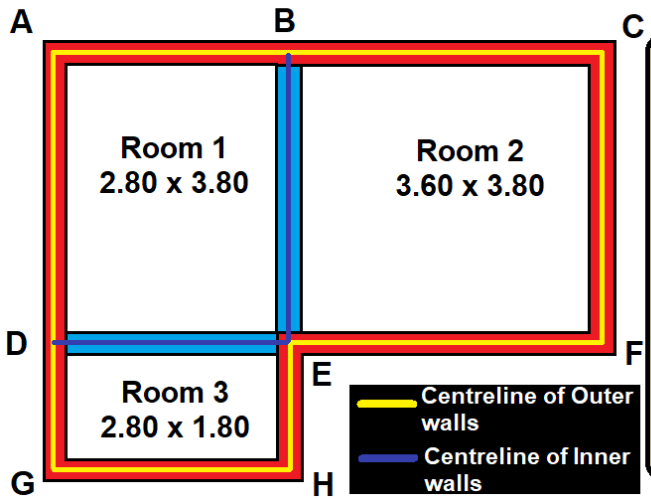
Therefore, Centreline Method can be easily used to determine the **Net Length (L)** of any of the following items.

- Earthwork in excavation
- PCC 1:4:8 in foundation
- RR masonry in CM 1:6 in foundation and basement.
- Damp-proof Course
- Brickmasonry in CM 1:6
- RCC 1:1.5:3 in Lintel band

Centreline Method

Centreline method can be used to determine quantities of such items as follows:





Centreline Length of:

(a) Outer Walls

= (2.80 + 0.30 + 3.60 + 0.30) + (3.80 + 0.30) + (3.60 + 0.30) + (1.80 + 0.30) + (2.80 + 0.30) + (1.80 + 0.30 + 3.80 + 0.30)

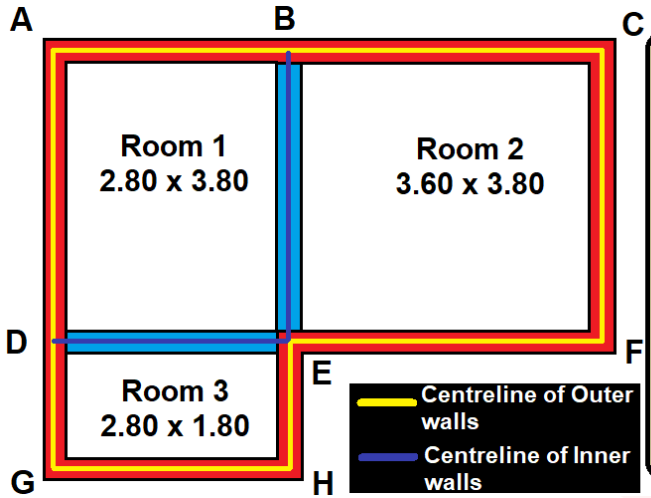
= 26.40m = CL_{outer}

(b) Inner Walls

= (3.80 + 0.30) + (2.80 + 0.30)

= 7.20m = CL_{inner}

Centreline Method



Centreline Length of:

(a) Outer Walls

= (2.80 + 0.30 + 3.60 + 0.30) + (3.80 + 0.30) + (3.60 + 0.30) + (1.80 + 0.30) + (2.80 + 0.30) + (1.80 + 0.30 + 3.80 + 0.30)

= 26.40m = CL_{outer}

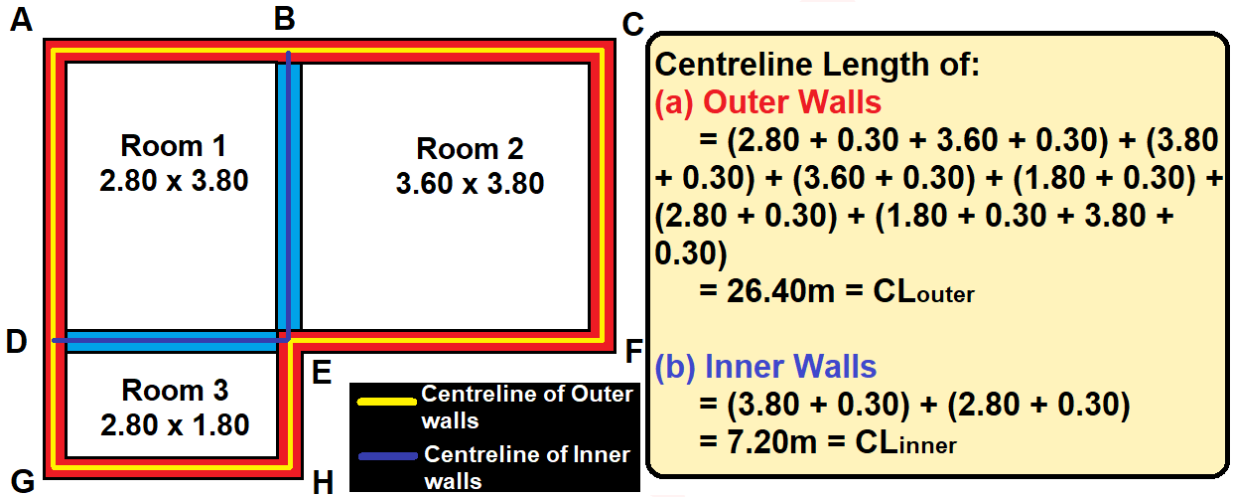
(b) Inner Walls

= (3.80 + 0.30) + (2.80 + 0.30)

= 7.20m = CL_{inner}

- No. of T-junctions in plan = 2
- No. of cross-junctions in plan = 1
- Net length of:
  - Earthwork in excavation
    L= 26.40 + 7.20 - (2 x $\frac{0.80}{2}$) - (1 x 0.80) = 32.00m
  - PCC 1:4:8 in foundation
    L= 26.40 + 7.20 - (2 x $\frac{0.80}{2}$) - (1 x 0.80) = 32.00m
  - RR masonry in CM 1:6 in foundation
    L= 26.40 + 7.20 - (2 x $\frac{0.60}{2}$) - (1 x 0.60) = 32.40m

Centreline Method



- Net length of:
  - RR masonry in CM 1:6 in basement
    L= 26.40 + 7.20 - (2 x $\frac{0.45}{2}$) - (1 x 0.45) = 32.70m
  - Damp-proof Course
    L= 26.40 + 7.20 - (2 x $\frac{0.45}{2}$) - (1 x 0.45) = 32.70m
  - Brickmasonry in CM 1:6
    L= 26.40 + 7.20 - (2 x $\frac{0.30}{2}$) - (1 x 0.30) = 33.00m
  - RCC 1:1.5:3 in Lintel band
    L= 26.40 + 7.20 - (2 x $\frac{0.30}{2}$) - (1 x 0.30) = 33.00m

Centreline Method

The Items thus quantified are tabulated as follows:

Sl. No.	Details of Item	No.	L (m)	B (m)	H (m)	Quantity
1	Earthwork in excavation	1	32.00	0.80	0.80	$20.48m^3$
2	PCC 1:4:8 in foundation	1	32.00	0.80	0.20	$5.12m^3$
3	RR masonry in CM 1:6 in					
	(a) foundation	1	32.40	0.60	0.60	$11.66m^3$
	(b) basement	1	32.70	0.45	0.45	$\underline{6.62m^3}$
	Total					$18.28m^3$
4	D.P.C B=0.45+0.45+0.45=1.35m	1	32.70	1.35		$44.15m^2$

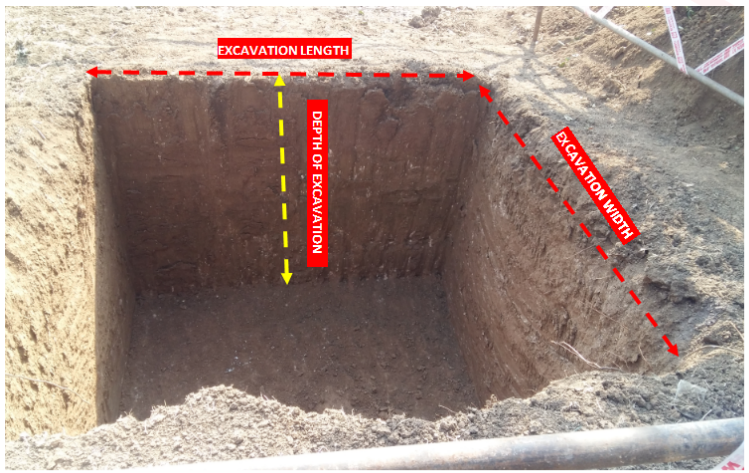
Centreline Method

Sl. No.	Details of Item	No.	L (m)	B (m)	H (m)	Quantity
5	Brickmasonry in CM 1:6	1	33.00	0.30	2.85	$28.22m^3$
	H=2.00+0.85=2.85m					
	Deductions:					
	D	1	1.00	0.30	2.00	-$0.60m^3$
	D1	2	0.80	0.30	2.00	-$0.96m^3$
	W1	4	1.00	0.30	1.50	-$1.80m^3$
	W2	2	1.50	0.30	1.50	-$1.35m^3$
	Total					$23.51m^3$
6	RCC 1:1.5:3 in Lintel band	1	33.00	0.30	0.15	$1.49m^3$

Note that we yielded the same quantities as obtained previously by Long wall–Short wall method.

More about Items of Work

1. **Earthwork:**
   - **Quantity:** Generally, measured in Volume (m^3)
   - **Measurement:**
     - Each dimension shall be measured to the nearest 0.01m.
     - Volumes shall be worked out to the nearest $0.01m^3$.



Earthwork for Column footing


Earthwork for Wall foundation

   - For the above cases, Volume is determined by:

Volume = Length x Width x Depth

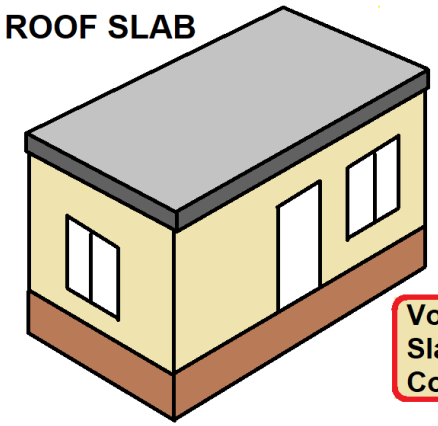
where, for wall foundation, the Length of earthwork in excavation is determined by Longwall–Shortwall/ Centreline Method.

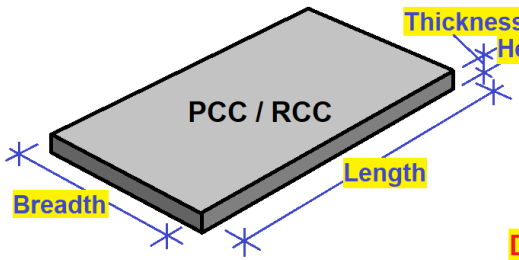
More about Items of Work

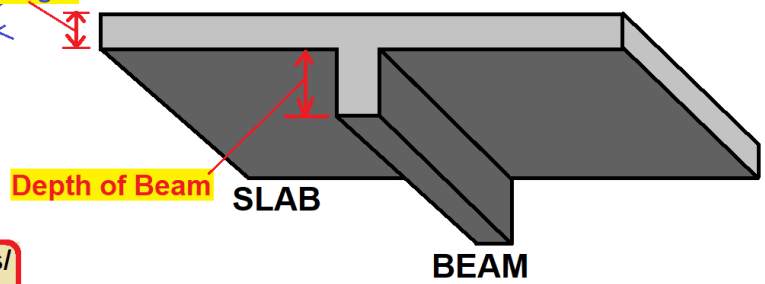
2. **Concrete Work:**
   - Plain, Reinforced and Prestressed concrete works shall each be measured separately.
   - **Quantity:** Generally, measured in Volume (m^3)
   - **Measurement:**
     - Dimensions shall be measured to nearest 0.01m, except for the thickness of slab which shall be measured to nearest 0.005 m.
     - Volumes shall be worked out to the nearest $0.01m^3$.
   - **Exemptions:** No deduction shall be made for the following cases:
     - for openings $\leq \mathbf{0.1}m^2$.
     - for the volume occupied by the steel reinforcements.
     - for volume occupied by pipes, conduits, etc of cross-sectional area $\leq \mathbf{100}cm^2$ for PCC and $\leq \mathbf{25}cm^2$ for RCC.
     - for volume occupied by ends of disssimilar materials (eg. steel beams, posts, etc) of cross-sectional area $\leq \mathbf{500}cm^2$.

More about Items of Work

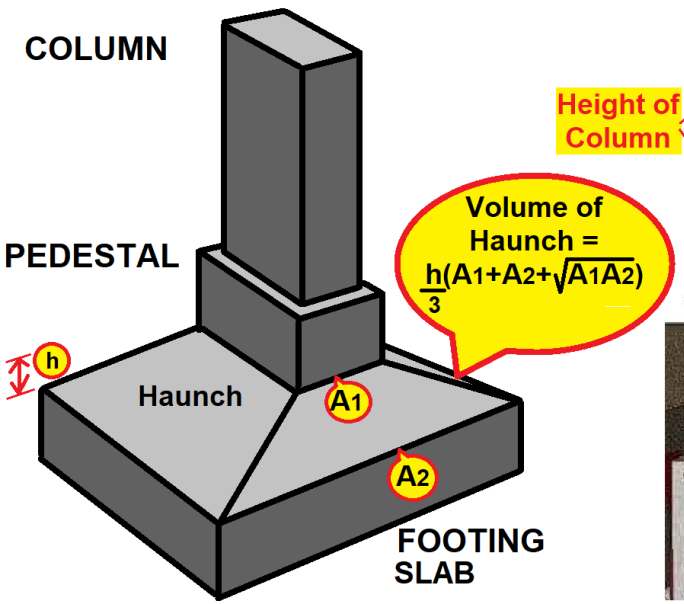
2 Concrete Work:



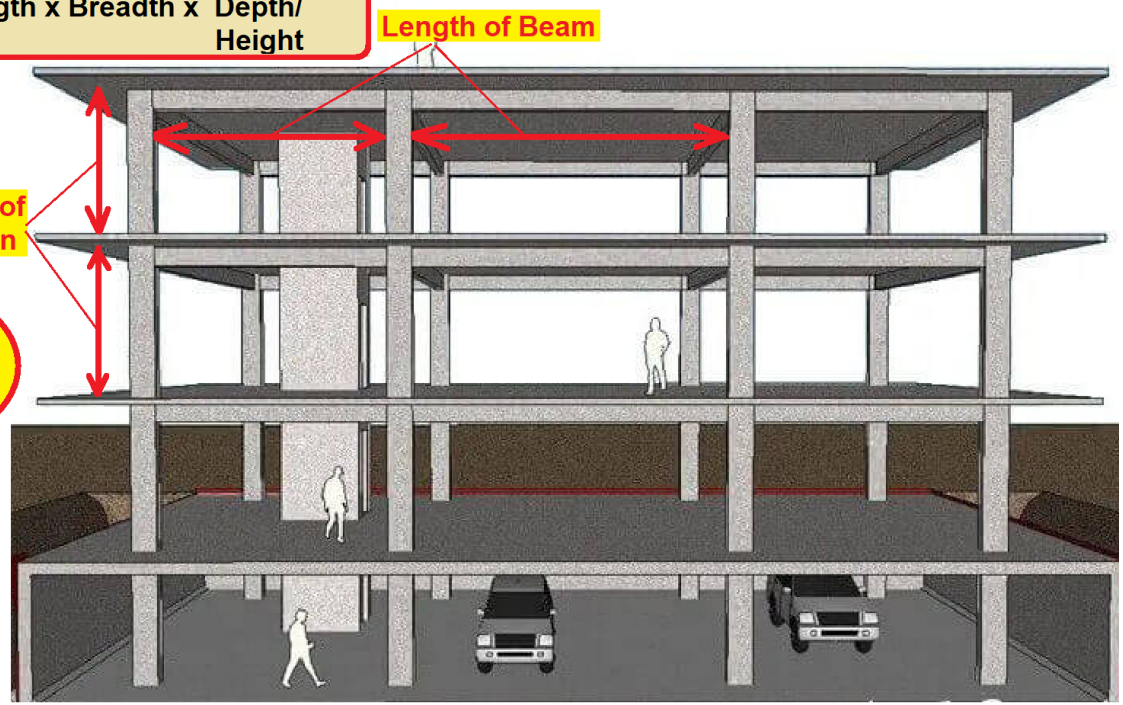




Volume of Slab/Beam/Column = Length x Breadth x Thickness/Depth/Height



Volume of Haunch = $\frac{h(A_1+A_2+\sqrt{A_1A_2})}{3}$

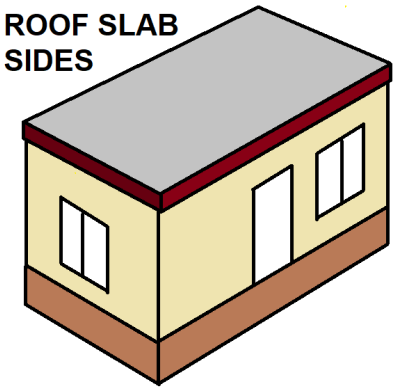


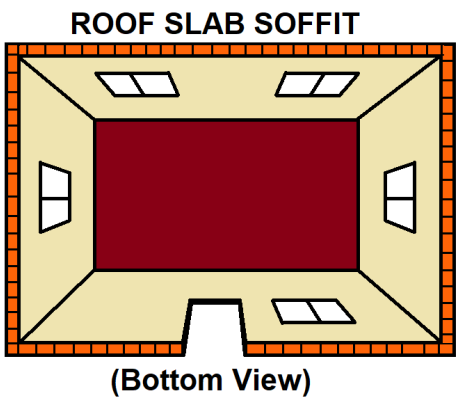
More about Items of Work

3. **Centering and Shuttering (Formwork):**
   - Formwork shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.
   - **Quantity:** Generally, measured in Area (m^2), in terms of area of surfaces in contact with concrete.
   - **Measurement:**
     - Dimensions shall be measured to nearest 0.01m.
     - Areas shall be worked out to the nearest $0.01m^2$.
   - **Exemptions:**
     - If there are any **openings** in formwork, no deductions shall be made for openings $\leq$**0.4**m^2.
     - In **grid beam system**, where **Secondary beams intersect Main beams**, no deduction shall be made from the formwork of the Main beam, where secondary beams intersect it.

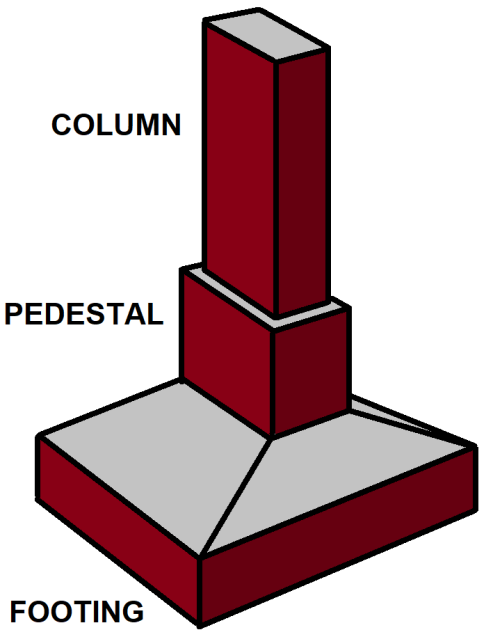
More about Items of Work

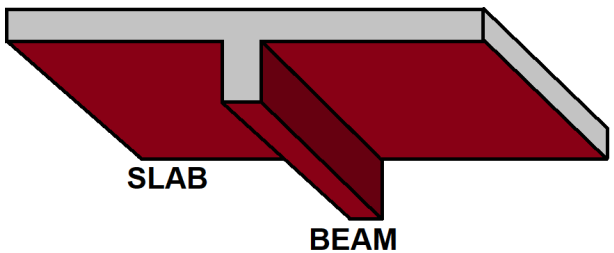
3 Centering and Shuttering (Formwork):






Openings in Formwork






Secondary Beam intersecting Main beam

Concrete Surfaces which require Formwork

More about Items of Work

4. **Stone Masonry:**
   - **Quantity:** Generally, measured in Volume (m^3)
   - **Measurement:**
     - Dimensions shall be measured to nearest 0.01m.
     - Volumes shall be worked out to the nearest $0.01m^3$.
   - **Exemptions:** No deduction shall be made for the following cases:
     - for openings $\leq \mathbf{0.1}m^2$.
     - for volume occupied by ends of disssimilar materials (eg. steel beams, posts, etc) of cross-sectional area $\leq \mathbf{0.1}m^2$.
     - Cement concrete blocks for holdfasts, holding-down bolts etc.

More about Items of Work

5 Brick Masonry:

- Bricks are of following types.

Type of Bricks	*Nominal Size mm*	*Actual Size mm*
Modular Bricks	200 × 100 × 100 mm	190 × 90 × 90 mm
Non-modular (FPS) bricks	229 × 114 × 70 mm	225 × 111 × 70 mm

- **Quantity:** Generally, measured in Volume (m^3)
- **Measurement:**
  - Dimensions shall be measured to nearest 0.01m.
  - Volumes shall be worked out to the nearest $0.01m^3$.
- Walls of thickness $\leq$ **half brick** shall each be measured separately in **square metres** (m^2) stating thickness.
  - Half brick thickness = 100mm (for modular bricks) ; 115 mm (for non-modular bricks).
- Walls of thickness $>$ half brick, as usual, are measured in m^3.
- **Exemptions:** No deduction shall be made for the following cases:
  - for openings $\leq$**0.1**m^2.
  - for volume occupied by ends of disssimilar materials (eg. steel beams, posts, etc) of cross-sectional area $\leq$**0.1**m^2.
  - Cement concrete blocks for holdfasts, holding-down bolts etc.

More about Items of Work

6. **Steel Reinforcement:**
   - Based on **IS 2502** (Code of Practice for Bending and Fixing of bars for Concrete Reinforcement)
   - To quantify Reinforcing steel, **Bar Bending Schedule** shall be prepared.
     - It is a tabular representation showing details of reinforcement bars used for a given RCC work.
     - It is prepared after the design of an RCC structural element.
     - It helps to estimate the quantity of reinforcing steel required for construction.
     - Further, it enables one to bend Bars in accordance with the appropriate dimensions shown in the schedule.

MEMBER	MARK	No. OF BARS	DIAMETER IN mm	LENGTH IN m/PIECE	TOTAL LENGTH IN m										BAR DETAILS	REMARKS
					#8	#6	#20	#14	#10	#8	#16					
SLAB a	1	12	8	2·90	34·80										260	
	2	12	8	3·62	43·44										135	
	23	2	20	2·20			4·40								220	
	24	2	20	2·20			4·40								70 118	
TOTAL LENGTH IN m/DIAMETER					299·31	27·25	47·42	3·80	5·60	56·46	24·00					
WEIGHT IN kg/m					0·395	0·222	2·464	1·208	0·617	0·395	1·578					
TOTAL WEIGHT IN kg/DIAMETER					118	6	117	5	3	22	38					

More about Items of Work

6 Steel Reinforcement:

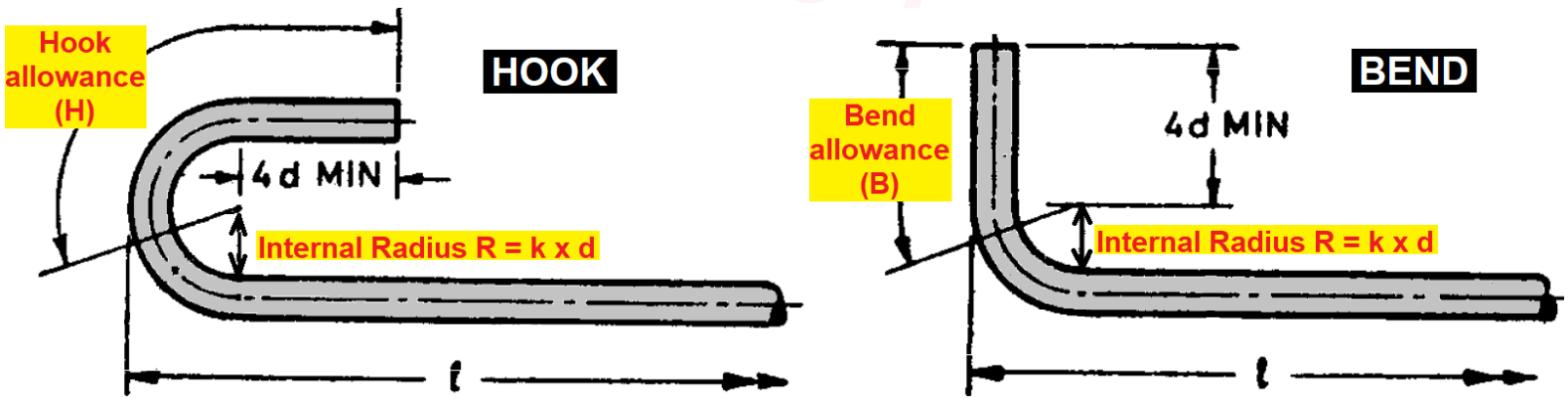
- **Quantity:** Generally, measured in Mass (kg)
- **Measurement:**
  - Reinforcement (including bends, hooks and laps) shall be measured in Length, measured to nearest 0.01m, separately for different diametres.
  - Then, their weight (in kg) is calculated on the basis of standard unit weight, given below (**IS 1786**).

Sl No.	Nominal Size mm	Cross-Sectional Area mm^2	Mass per Metre kg
i)	4	12.6	0.099
ii)	5	19.6	0.154
iii)	6	28.3	0.222
iv)	8	50.3	0.395
v)	10	78.6	0.617
vi)	12	113.1	0.888
vii)	16	201.2	1.58
viii)	20	314.3	2.47
ix)	25	491.1	3.85
x)	28	615.8	4.83
xi)	32	804.6	6.31
xii)	36	1 018.3	7.99
xiii)	40	1 257.2	9.86

More about Items of Work

6 Steel Reinforcement:

- **Bends** & **Hooks in bars:** Generally, Bends and Hooks in bars are designated by **Diameter of bar (d)**, **Internal Radius (R)**, **Hook allowance (H)** and **Bend allowance (B)**.



Properties	For MS bars		For HYSD bars	
	d≤25mm	d>25mm	d≤25mm	d>25mm
Internal Radius (R)	2d	3d	4d	6d
Hook Allowance (H)	9d	11d	13d	17d
Bend Allowance (B)	5d	5.5d	6d	7d

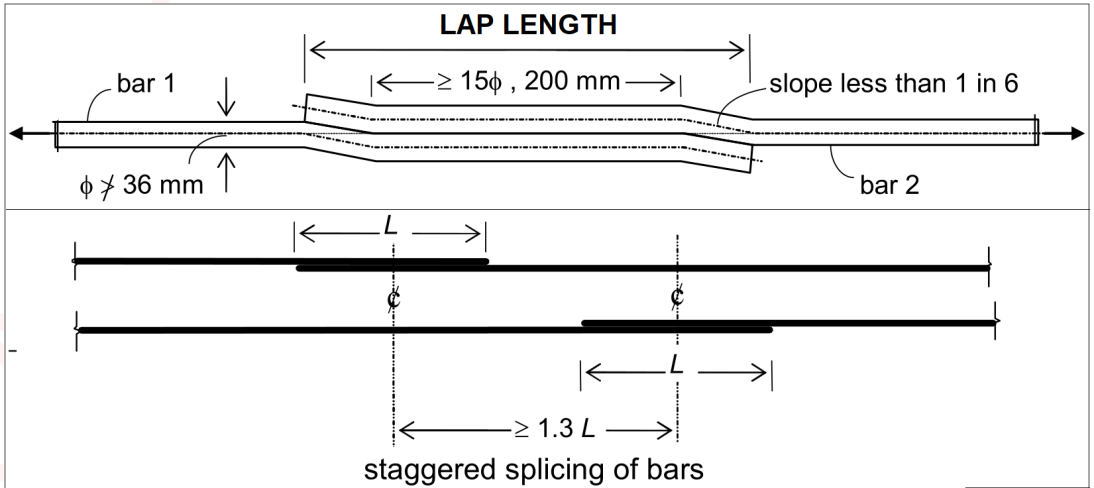
1. Minimum value of H and B shall be **75mm**.
2. H and B values determined as above, shall be rounded off to the nearest **5mm**.

More about Items of Work

6 Steel Reinforcement:

- **Lap Splicing of Bars:**
  - The standard length of bars available from mills is generally 12 m.
  - Due to **non-availability of longer bars**, splicing of bars is required.
  - According to IS 456, Lap splices may be used for bar dia $\phi \leq$ **36 mm**.
  - Lap length should at least be equal to the **development length (L_d).**
  - From table,

    Lap Length $\approx$ 50d



staggered splicing of bars

L_d / ϕ values for fully stressed bars in tension*

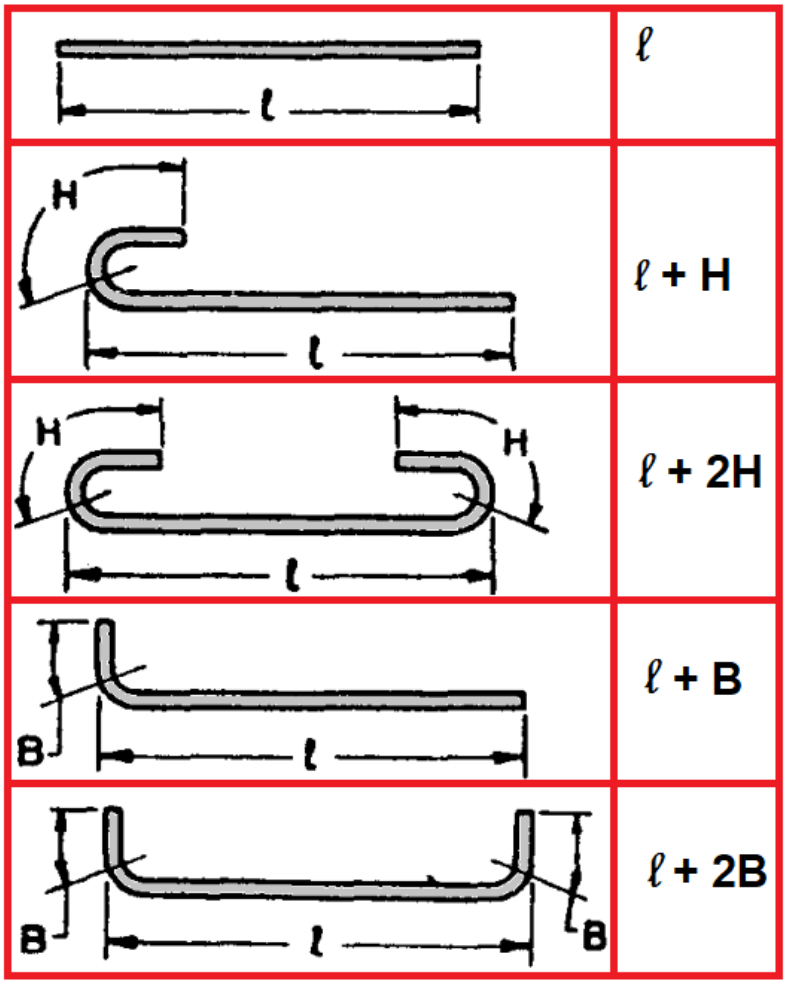
Grade of Steel	Grade of concrete				
	M 20	M 25	M 30	M 35	M 40 and above
Fe 250	45	39	36	32	29
Fe 415	47	40	38	33	30
Fe 500	57	49	45	40	36

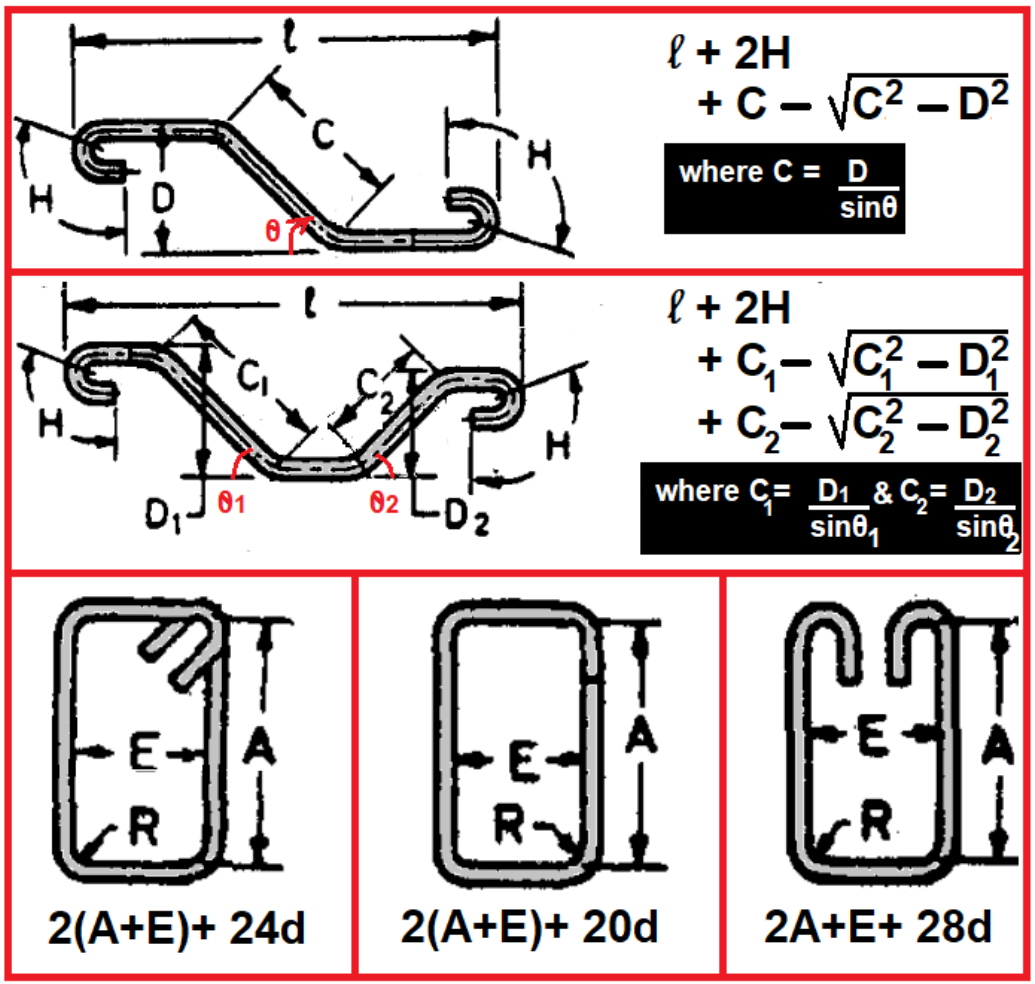
*for bars in *compression*, multiply these values of L_d / ϕ by 0.8.

Ref: Reinforced Concrete Design by Unnikrishna Pillai & Devdas Menon

More about Items of Work

6. **Steel Reinforcement:** Formula for determination of Length of bars for different cases.





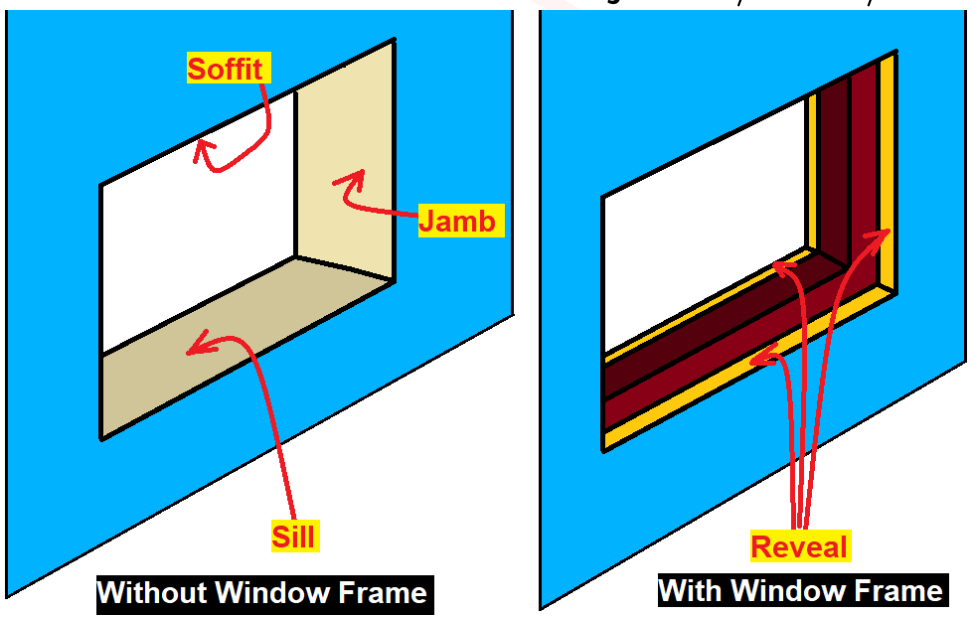
More about Items of Work

7. **Plastering:**
   - **Quantity:** Generally measured in Area (m^2)
   - **Measurement:**
     - Length and breadth shall be measured correct to 0.01m.
     - Area shall be calculated correct to 0.01m^2.
   - Plastering on roofs, ceilings and walls shall be measured separately.
   - Wall plaster is computed as:
     Quantity = Length of Wall surface x Height of Wall surface.
     - Length is measured between the walls or partitions (the dimensions before the plaster shall be taken).
     - Height is measured between top of floor surface/skirting to the ceiling.

More about Items of Work

7 Plastering:

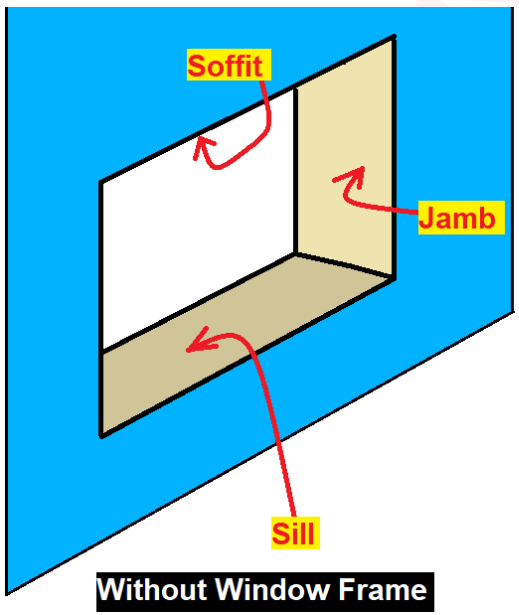
- **Deductions in measurement for Openings:**
  - **For openings of area $\leq 0.5 m^2$:**
    (i) No deductions shall be made.
    (ii) No additions shall be made for jambs/soffit/sill of that opening.

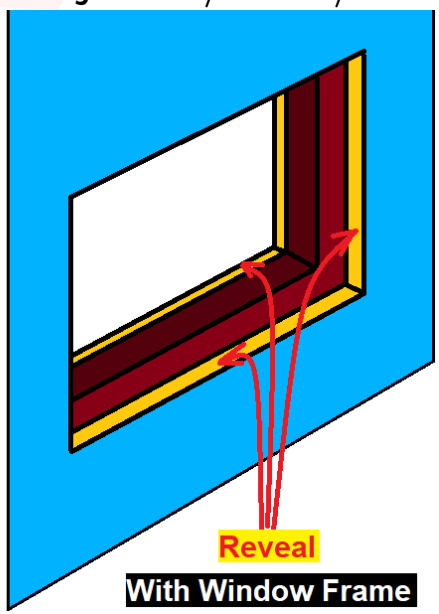


More about Items of Work

7 Plastering:

- **Deductions in measurement for Openings:**
  - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
    Subcase 1: If both faces of walls are plastered with same plaster,
    (i) deductions shall be made for one face only.
    (ii) No additions shall be made for jambs/soffit/sill of that opening.

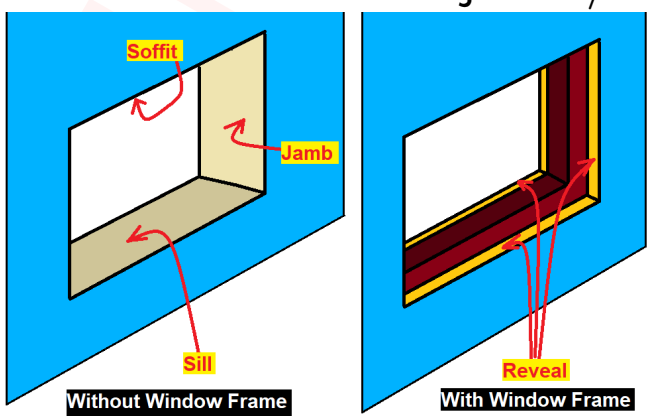




More about Items of Work

7 Plastering:

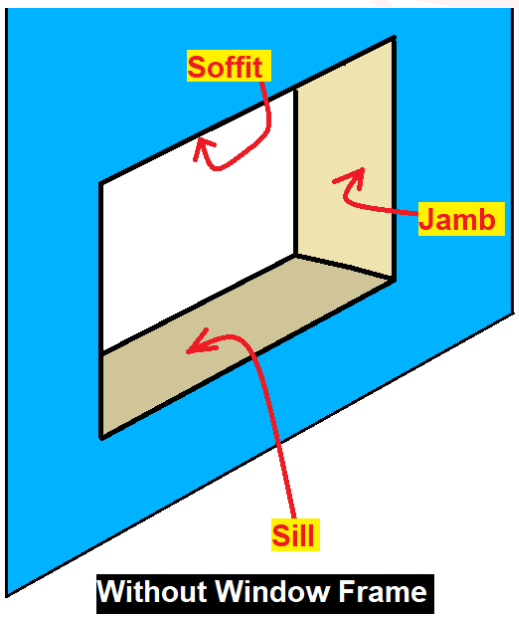
- **Deductions in measurement for Openings:**
  - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
    Subcase 2: If two faces of wall are plastered with different types of plaster,
    (i) deduction shall be made only from the plaster on that side of wall on which width of reveal is less than that on the other side,
    (ii) no deduction shall be made on the other side with greater width of reveal.
    (iii) If widths of reveals on both faces of wall are equal, deduction of 50 % of area of opening shall be made on each face of wall.
    (iv) No additions shall be made for jambs/soffit/sill of that opening.



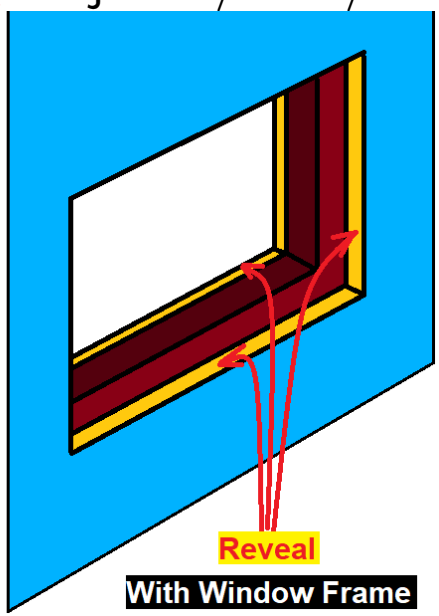
More about Items of Work

7 Plastering:

- **Deductions in measurement for Openings:**
  - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
    Subcase 3: If only one face is plastered and the other face is not,
    (i) deduction shall be made from plaster, if width of reveal on plastered side is less than that on unplastered side
    (ii) if widths of reveal on both sides are equal or width of reveal on plastered side is more, no deduction shall be made.
    (iii) No additions shall be made for jambs/soffit/sill of that opening.



Without Window Frame

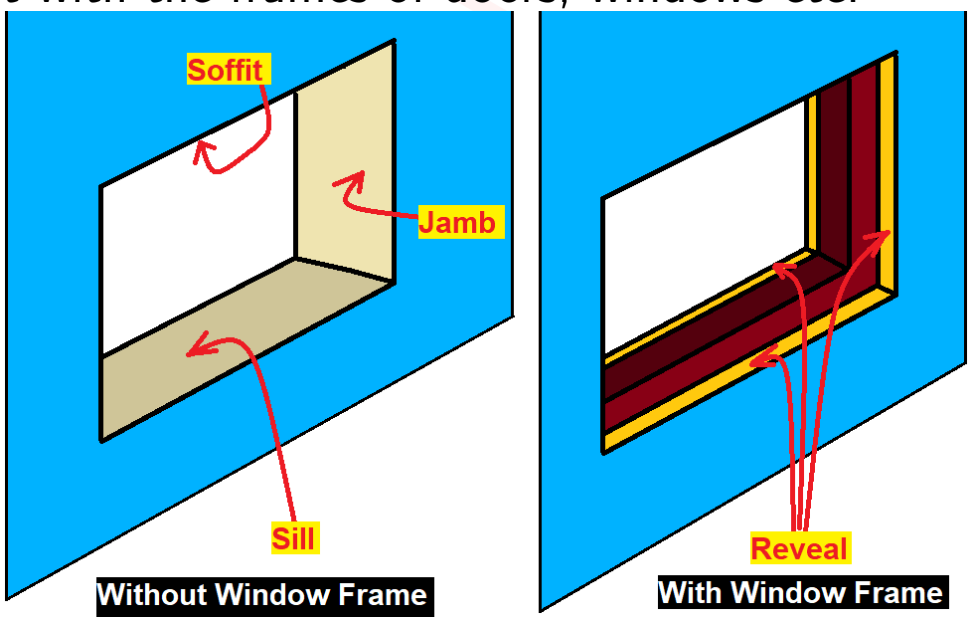


With Window Frame

More about Items of Work

7 Plastering:

- **Deductions in measurement for Openings:**
  - **For openings of area $>3m^2$:**
    (i) deduction shall be made for opening on each face
    (ii) Addition of area of jambs, soffits and sills shall be made. Note that, deduction shall not be made for the area of jambs/soffit/sill in contact with the frames of doors, windows etc.



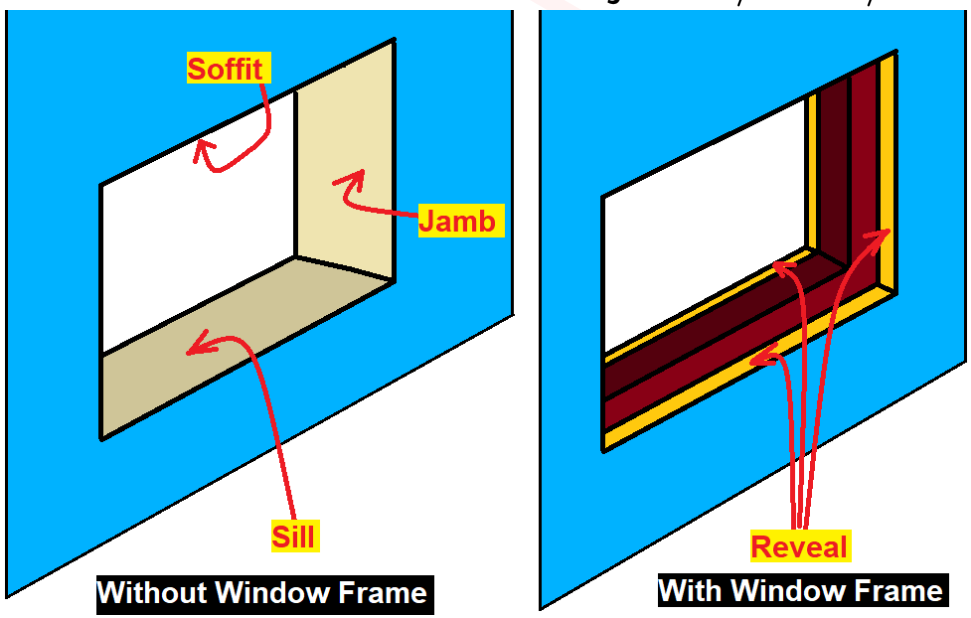
More about Items of Work

8. **Painting:**
   - **Quantity:** Generally measured in Area (m^2)
   - **Measurement:**
     - Length and breadth shall be measured correct to 0.01m.
     - Area shall be calculated correct to 0.01m^2.
   - Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.
   - The **primer** for wood work, iron work or plastered surface shall be as specified below (also measured in Area (m^2)).

S.No	*Surfaces*	*Primer to be used*
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer conforming to IS 3585
3.	(A) Aluminium and light alloys	Zinc chromate primer conforming to IS 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer conforming IS 2074
4.	Cement/Conc/RCC/brick work, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer conforming to IS 109

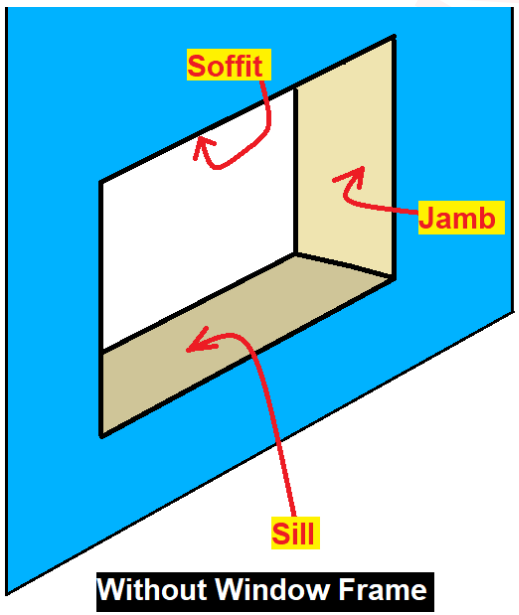
More about Items of Work

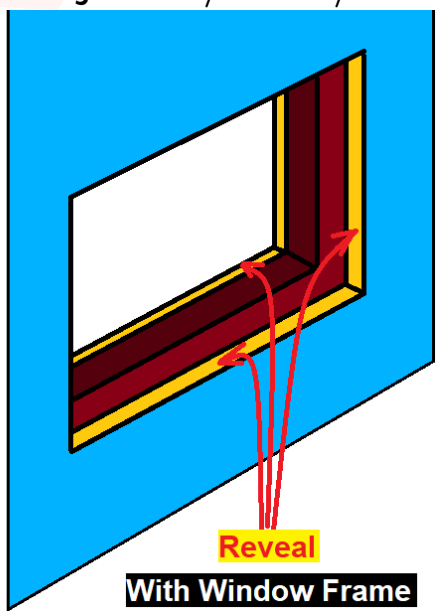
8. **Painting:**
   - **Deductions in measurement for Wall Openings:**
     - **For openings of area $\leq 0.5 m^2$:**
       (i) No deductions shall be made.
       (ii) No additions shall be made for jambs/soffit/sill of that opening.



More about Items of Work

8. **Painting:**
   - **Deductions in measurement for Wall Openings:**
     - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
       Subcase 1: If both faces of walls are provided with same finish,
       (i) deductions shall be made for one face only.
       (ii) No additions shall be made for jambs/soffit/sill of that opening.

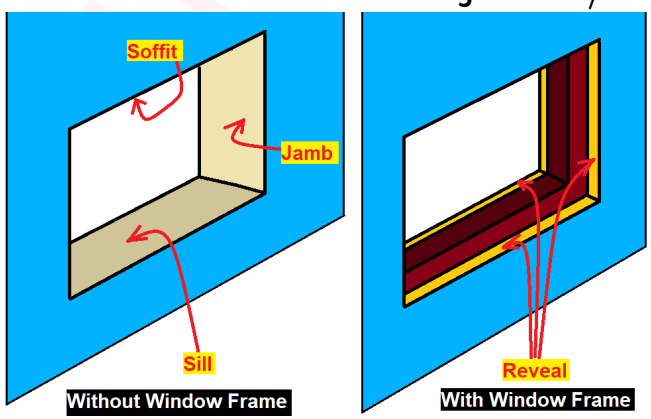




More about Items of Work

8 Painting:

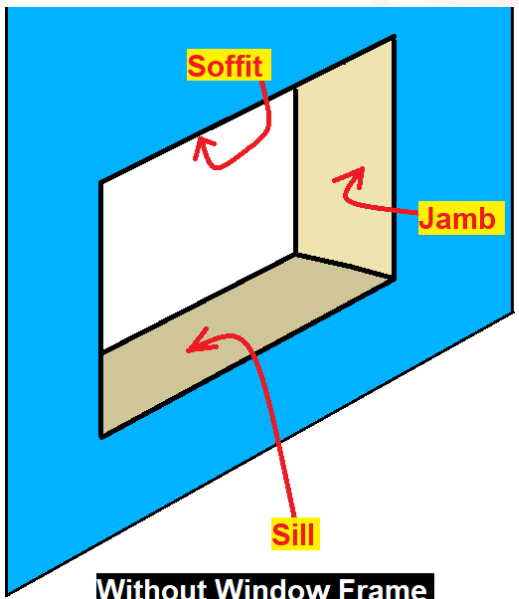
- **Deductions in measurement for Wall Openings:**
  - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
    Subcase 2: If two faces of wall are provided with different types of finish,
    (i) deduction shall be made only from the finish on that side of wall on which width of reveal is less than that on the other side,
    (ii) no deduction shall be made on the other side with greater width of reveal.
    (iii) If widths of reveals on both faces of wall are equal, deduction of 50 % of area of opening shall be made on each face of wall.
    (iv) No additions shall be made for jambs/soffit/sill of that opening.



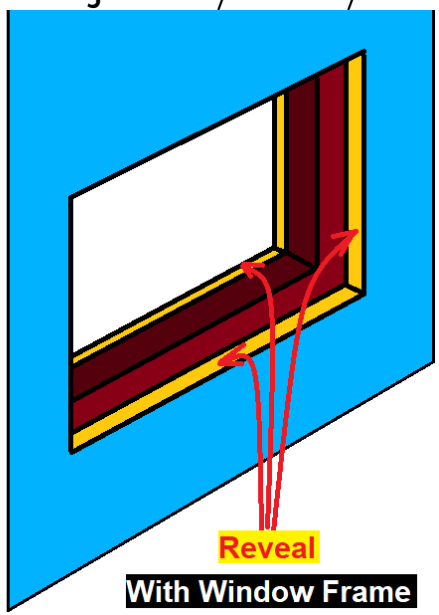
More about Items of Work

8 Painting:

- **Deductions in measurement for Wall Openings:**
  - **For openings of area $>0.5m^2$ and $\leq 3m^2$:**
    Subcase 3: If only one face is treated and the other face is not,
    (i) deduction shall be made from finish, if width of reveal on treated side is less than that on untreated side
    (ii) if widths of reveal on both sides are equal or width of reveal on treated side is more, no deduction shall be made.
    (iii) No additions shall be made for jambs/soffit/sill of that opening.



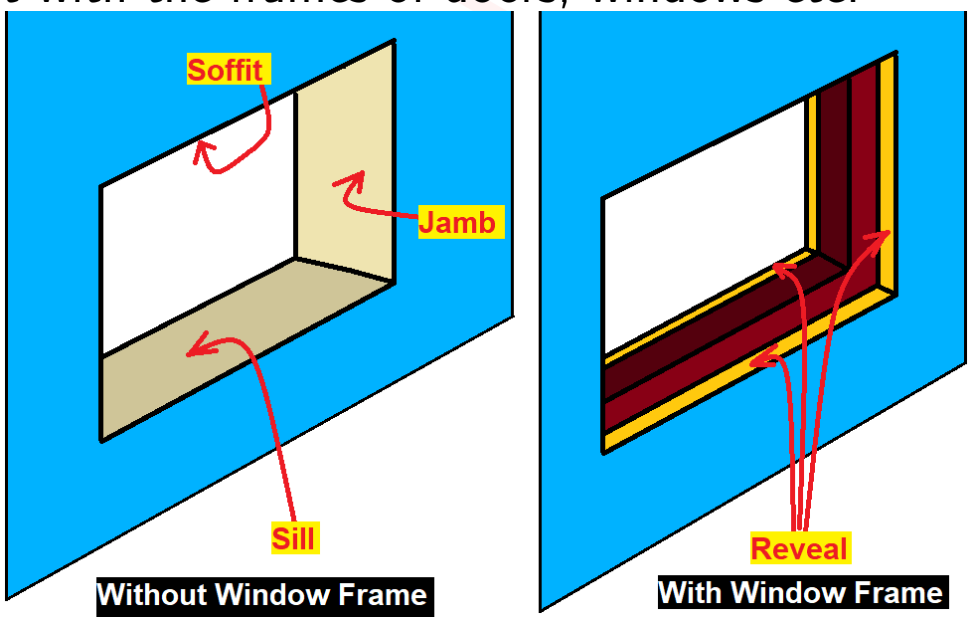
Without Window Frame



With Window Frame

More about Items of Work

8. **Painting:**
   - **Deductions in measurement for Wall Openings:**
     - **For openings of area $>3m^2$:**
       (i) deduction shall be made for opening on each face
       (ii) Addition of area of jambs, soffits and sills shall be made. Note that, deduction shall not be made for the area of jambs/soffit/sill in contact with the frames of doors, windows etc.



More about Items of Work

8 Painting:

- In measuring areas of **uneven surfaces** of painting, varnishing, etc. of woodwork, steel work etc., the following **coefficients** shall be used to obtain the actual area payable. The coefficients shall be applied to the **areas measured flat** and **not girthed**. **(Contd...)**

S.No	Description of work	How measured	Multiplying coefficient
1	2	3	4
I. Wood work doors, windows Etc.			
1.	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	-do-
3.	Flush doors etc.	-do-	1.20 (for each side)
4.	Part panelled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	-do-	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	-do-	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	-do-	1.80 (for each side)
7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 (for painting all over)
8.	Carved or enriched work	Measured flat	
9.	Weather boarding	Measured flat (not girthed supporting frame work shall not be measured separately	1.20 (for each side)
10.	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)

More about Items of Work

8 Painting:

- In measuring areas of **uneven surfaces** of painting, varnishing, etc. of woodwork, steel work etc., the following **coefficients** shall be used to obtain the actual area payable. The coefficients shall be applied to the **areas measured flat** and **not girthed**.**(Contd...)**

S.No	Description of work	How measured	Multiplying coefficient
1	2	3	4
II. Steel work doors, windows Etc.			
13.	Plain sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)	-do-	0.50 (for each side)
15.	Partly panelled and partly glazed or gauzed doors and windows (excluding painting of wire gauze portion)	-do-	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	-do-	1.25 (for each side)
17.	Collapsible gates	Measured flat	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat (size of opening) all over; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)

More about Items of Work

8 Painting:

- In measuring areas of **uneven surfaces** of painting, varnishing, etc. of woodwork, steel work etc., the following **coefficients** shall be used to obtain the actual area payable. The coefficients shall be applied to the **areas measured flat** and **not girthed**.

S.No	Description of work	How measured	Multiplying coefficient
1	2	3	4
III. General			
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	-do- (See note No.12)	1 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	-do- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	-do-	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	-do-	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	-do-	1.00 (for each side)
25.	Hait Cut Bamboo fencing	-do-	1.38 (AV) (for each side)

More about Items of Work

9. **Woodwork:**

(a)In Frames of Doors, Window & Ventilators

- **Quantity:** Generally, measured in Volume (m^3)
- **Measurement:**
  - Length shall be measured to nearest 0.01m. Width & thickness shall be measured to nearest 0.001m.
  - Volumes shall be worked out to the nearest $0.001m^3$.
- Wooden members of uniform rectangular cross-section shall be measured for finished dimension without any allowance for the wastage.
- For such members having mouldings, roundings, rebates, varying sections, etc., finished dimensions shall be taken as the **sides of the smallest rectangle** from which such a section can be cut.

More about Items of Work

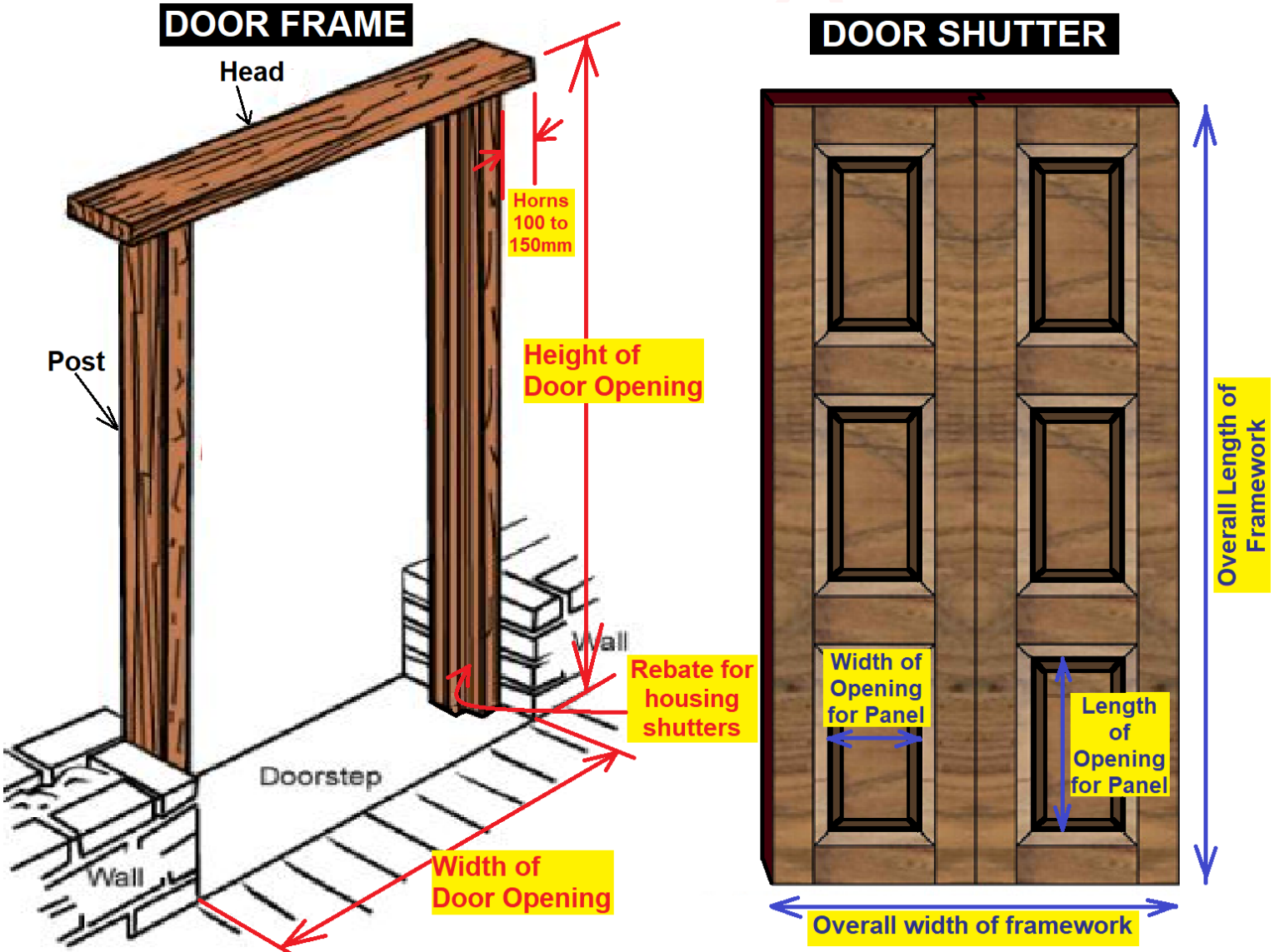
9. **Woodwork:**

(b)In Glazed/Panelled Shutters of Doors, Window & Ventilators

- Framework and panelling of shutters shall be measured separately.
- **Quantity:** Generally, measured in Area (m^2)
- **Measurement:**
  - Dimensions shall be measured to nearest 0.01m.
  - Area shall be worked out to the nearest $0.01m^2$.
- **Framework:**
  - Overall length and width of the framework of the shutters shall be measured.
  - No deduction shall be made to account the effect of panel openings.
- **Panelling:**
  - Length and width of opening for panels/ glazed panels is measured.
  - The portions of the panel/ glazed panel inside the grooves or rebates shall not be measured.

More about Items of Work

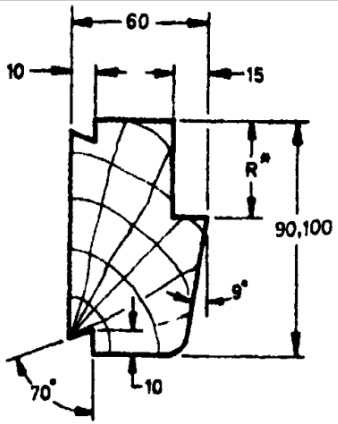
9 Woodwork:



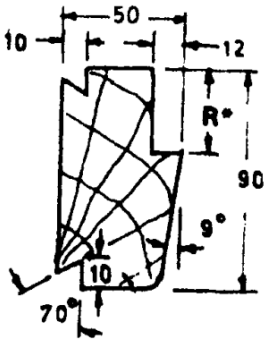
More about Items of Work

9 Woodwork:

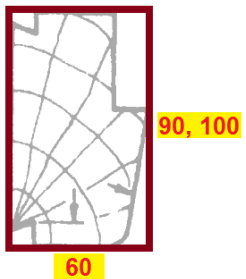
STANDARD DIMENSIONS OF FRAME CROSS-SECTION
(As per IS 4021)



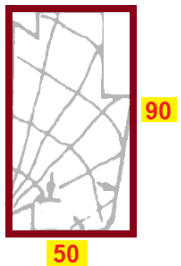
*R (Thickness of shutters) = 25, 30, 35 or 40 mm.
All dimensions in millimetres.
FIG. 5 TYPICAL CROSS SECTION OF FRAME FOR DOORS AND LARGE WINDOWS CARRYING ONE SET OF SHUTTERS



*R (Thickness of shutters) = 25, 30, 35 or 40 mm.
All dimensions in millimetres.
FIG. 6 TYPICAL CROSS SECTION OF FRAME FOR SMALL WINDOW AND VENTILATOR CARRYING ONE SET OF SHUTTERS



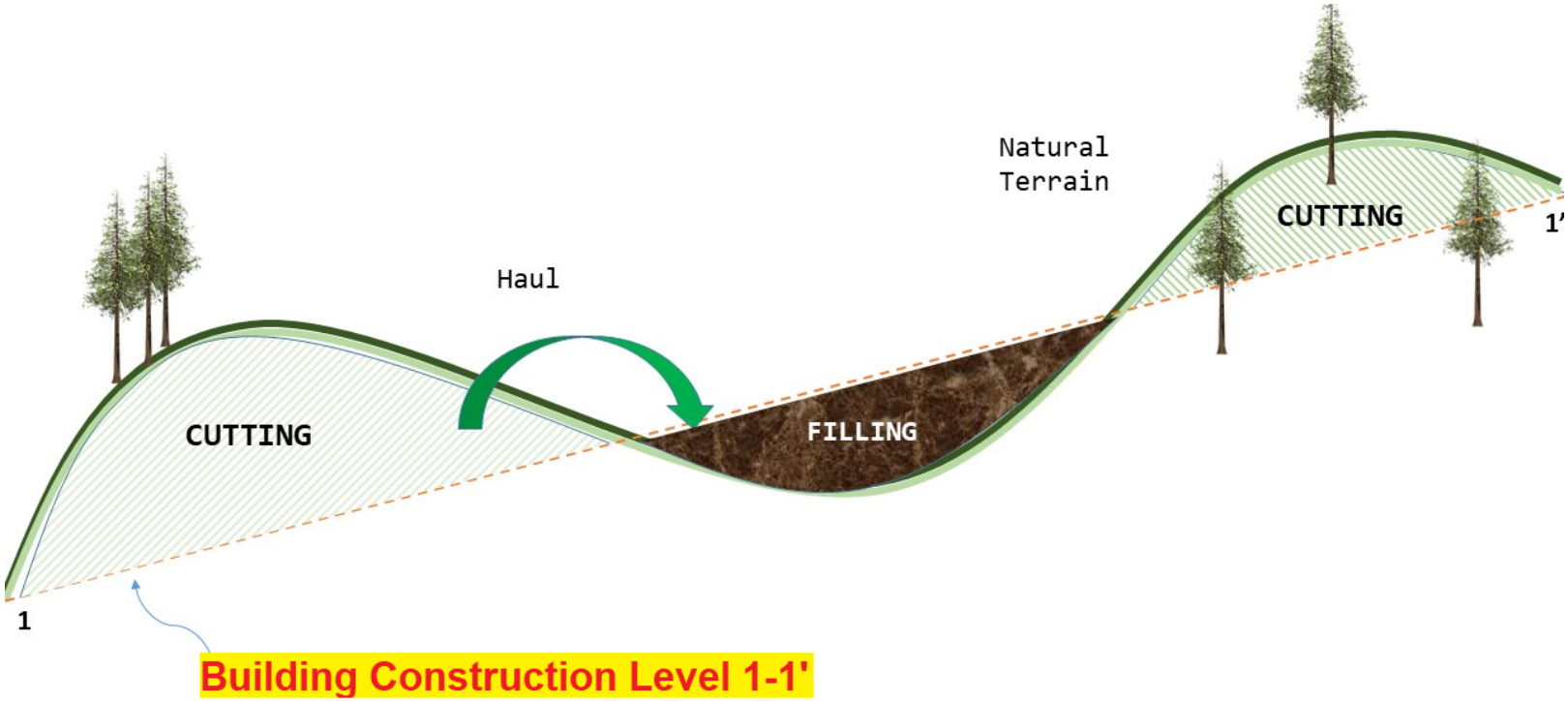
Smallest Rectangular section, which perfectly fits the original wooden section



More about Items of Work

10. **Land Levelling (Part of Earthwork):**
    - **Land leveling** is the process of modifying the surface relief by smoothening it.
    - It is the process of flattening or modifying existing (natural) slopes or undulations and thereby creating a level surface.
    - Normally land leveling requires excavation and movement of earth from higher elevations to lower elevations.
    - **Land grading** is modifying the slope of land to a planned grade (slope) and specifications for different purposes (e.g. irrigation planning).

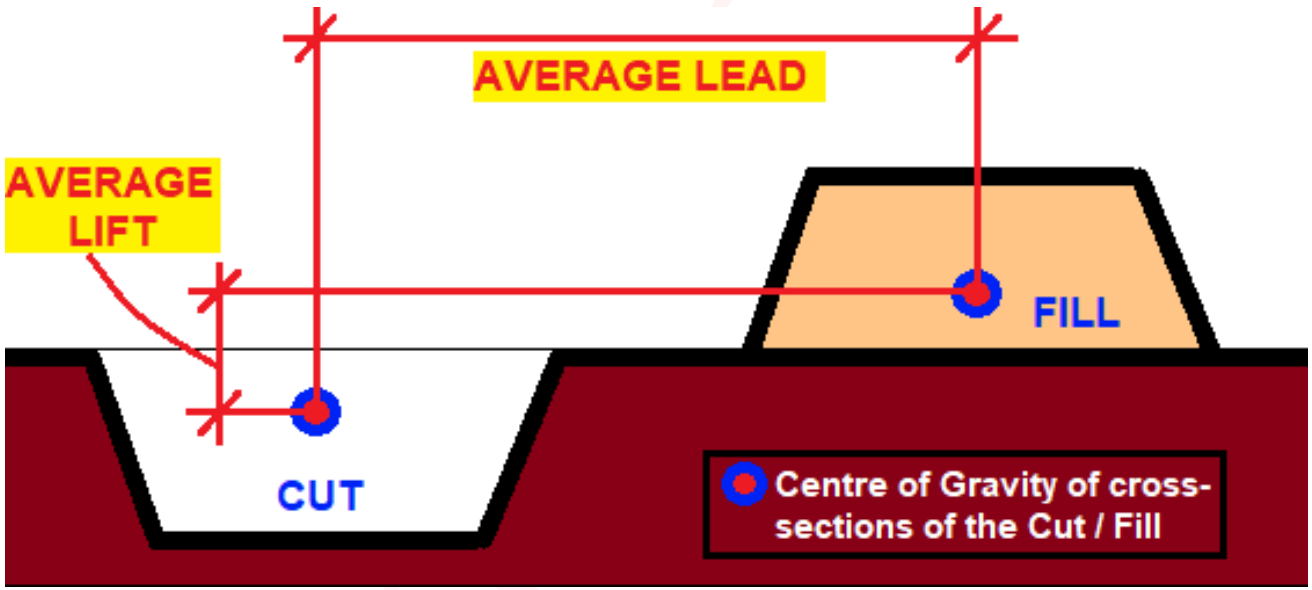
More about Items of Work



- Consider a natural terrain that needs to be converted into a level 1-1' for a construction project, as shown in Figure.
- For this, some portions of the terrain need **cutting**, while some portion demands **filling**.
- In certain situations, the earth from cutting is loaded to fill a depression or a dipping area as shown. This process is **hauling**.

More about Items of Work

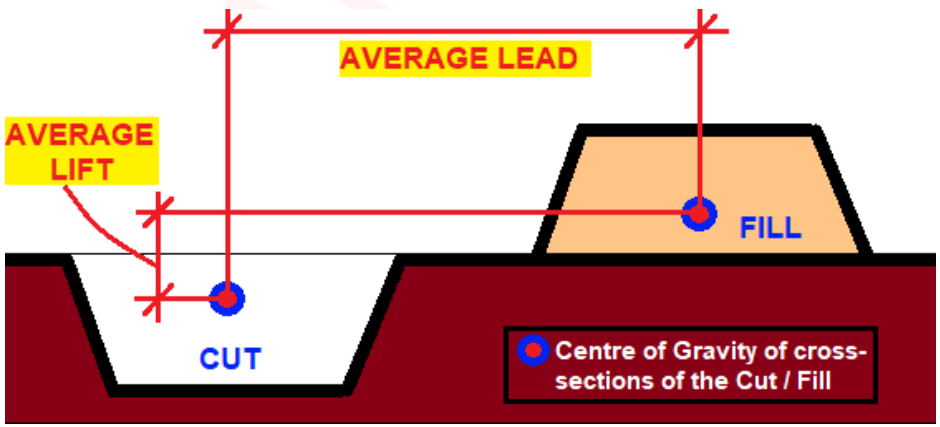
This may be idealized as follows for the purpose of study:



There arise the necessity to define two important terms – **Lead** & **Lift**

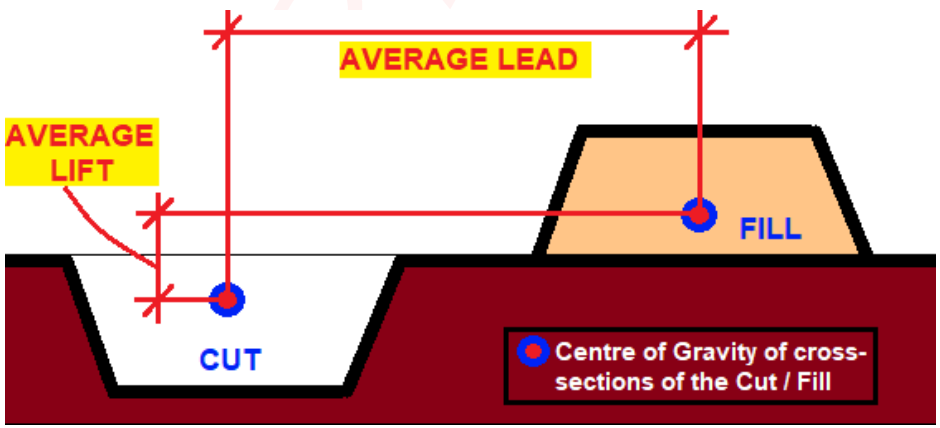
More about Items of Work

1. **Lead:**
   - Average straight horizontal distance through which the earth can be carried from the source to the place of deposit or filling.
   - It is not necessarily the route actually followed.
   - Measured in units/multiples of:
     (i) **50m** (for distances $\leq$250m)
     (ii) **250m** (for distances $>$250m and $\leq$500m)
     (iii) **500m** (for distances $>$500m and $\leq$5km)
     (iv) **1km** (for distances $>$5km)
   - Items shall include loading and unloading.
   - Carriage by **manual labour** shall be reckoned in units of **50 metres**.
   - Carriage by **animal** and **mechanical transport** shall be reckoned in **1 km** unit.



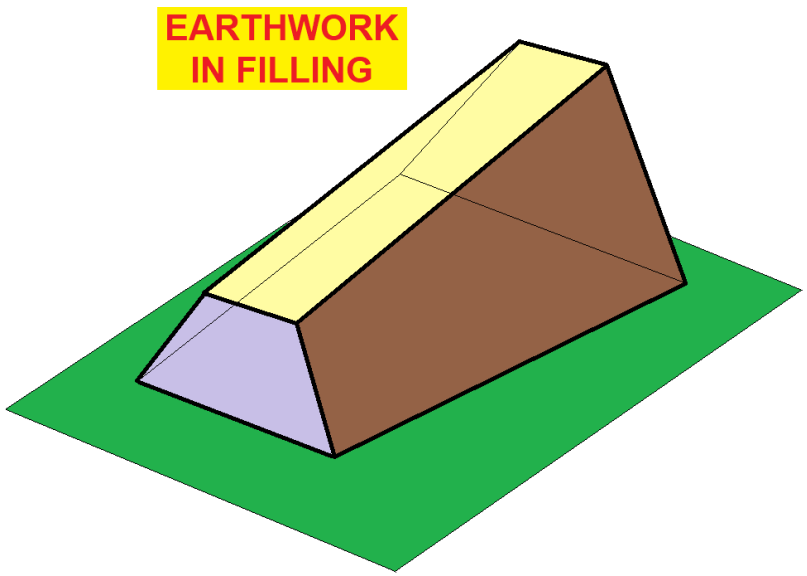
More about Items of Work

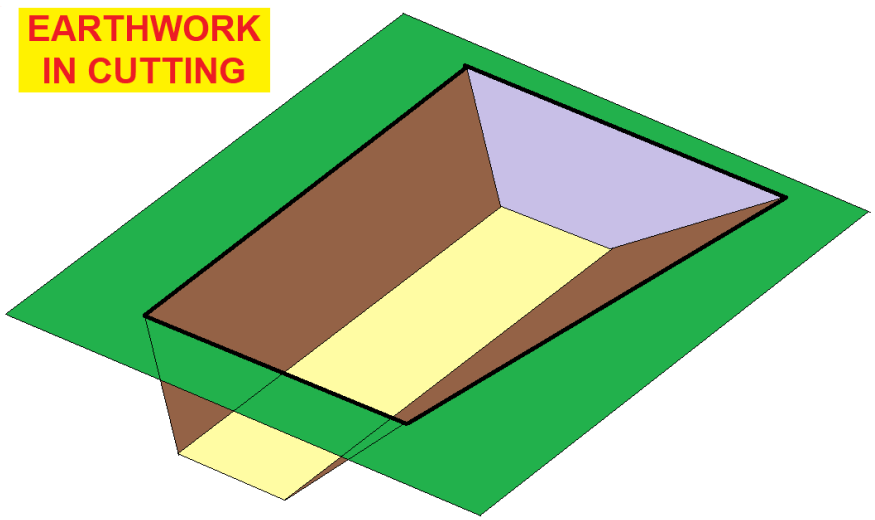
2. **Lift:**
   - Average straight vertical distance through which the earth can be lifted from the source to the place of deposit or filling.
   - The vertical distance for removal with reference to the ground level.
   - Excavation up to **1.5 m** depth below ground level and depositing excavated material on the ground shall be included in the item of earthwork for various kinds of soil.
   - Extra lift shall be measured in unit of 1.5 m or part thereof.
   - **Obvious lifts** shall only be measured; i.e., lifts inherent in the lead due to ground slope shall not be measured.



More about Items of Work

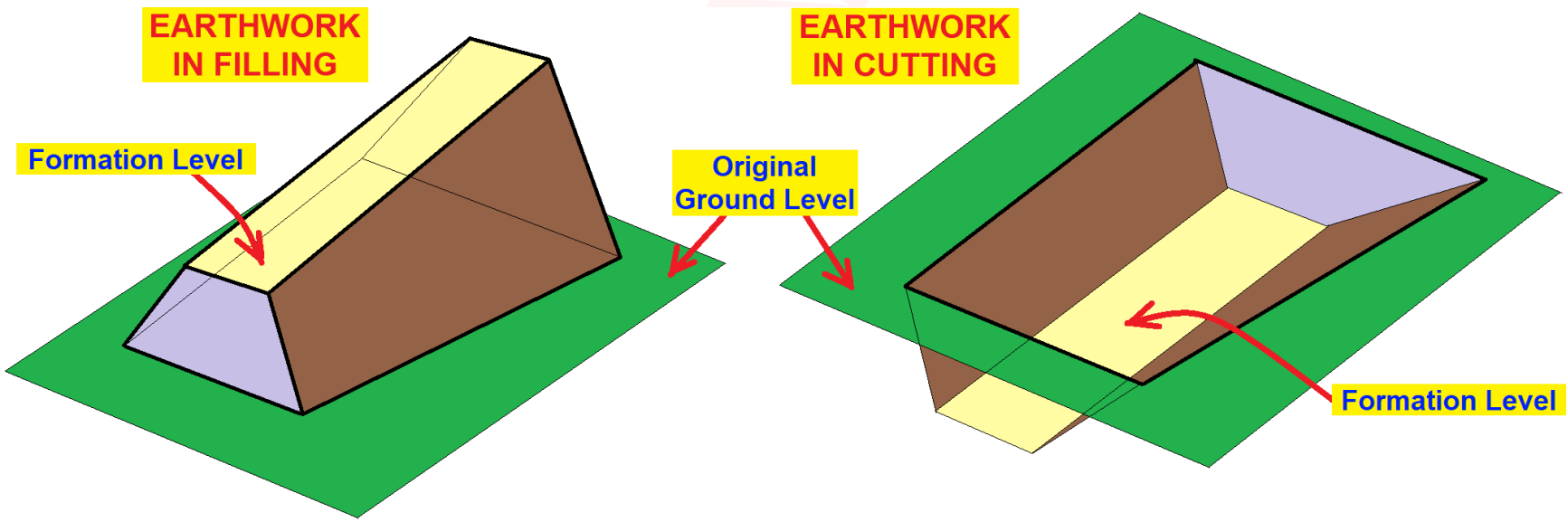
Generally, for the construction of pavements, there involves earthwork in cutting or filling, which shall have cross-sections of the shape of **trapezium**. Such a solid may be called **"Prismoid"**, as shown.





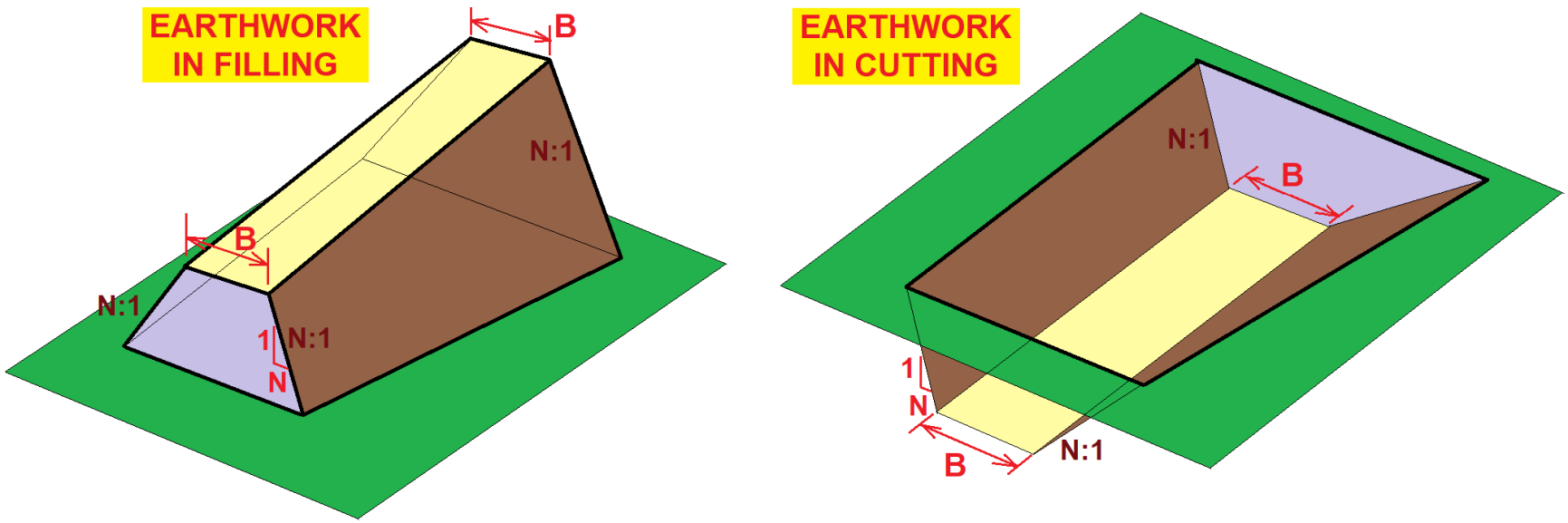
More about Items of Work

- Roads are generally constructed at the desired gradient, the level corresponding to which is called Formation level.
- To obtain this level, it may sometimes require to raise the original ground (by filling) or depress the original ground (by cutting).



More about Items of Work

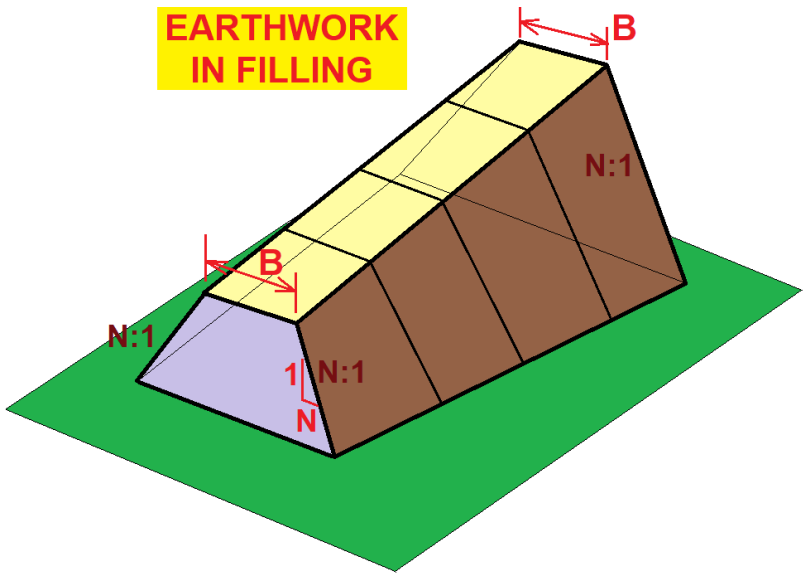
The dimensions of the **cut** and **fill** are shown here.

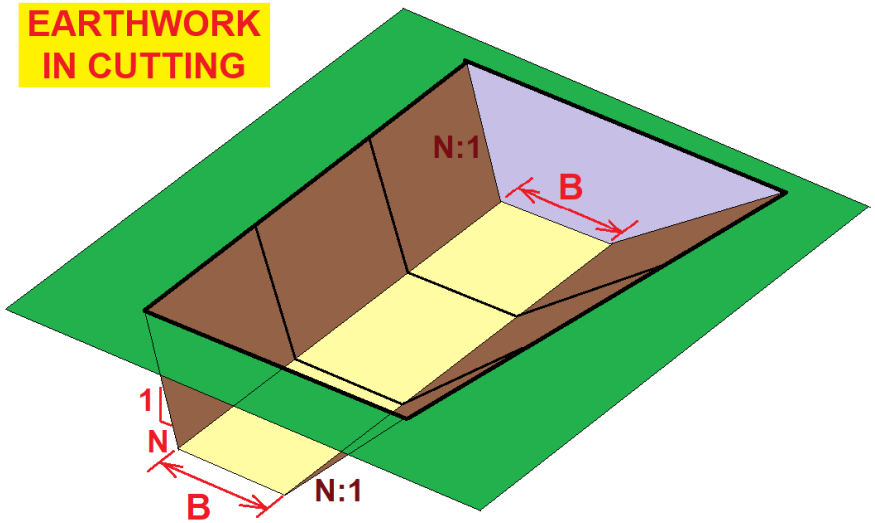


B = top (crest) width of fill / bottom (trough) width of cut
= **Formation Width**
d = depth of fill / cut, which may vary along the longitudinal axis
N:1 = side slope, expressed as horizontal : vertical

More about Items of Work

Since the **depth of the prismoid varies along its longitudinal axis**,
inorder to determine the **volume of earthwork**,
we consider **intermediate sections** along the longitudinal axis, as shown.

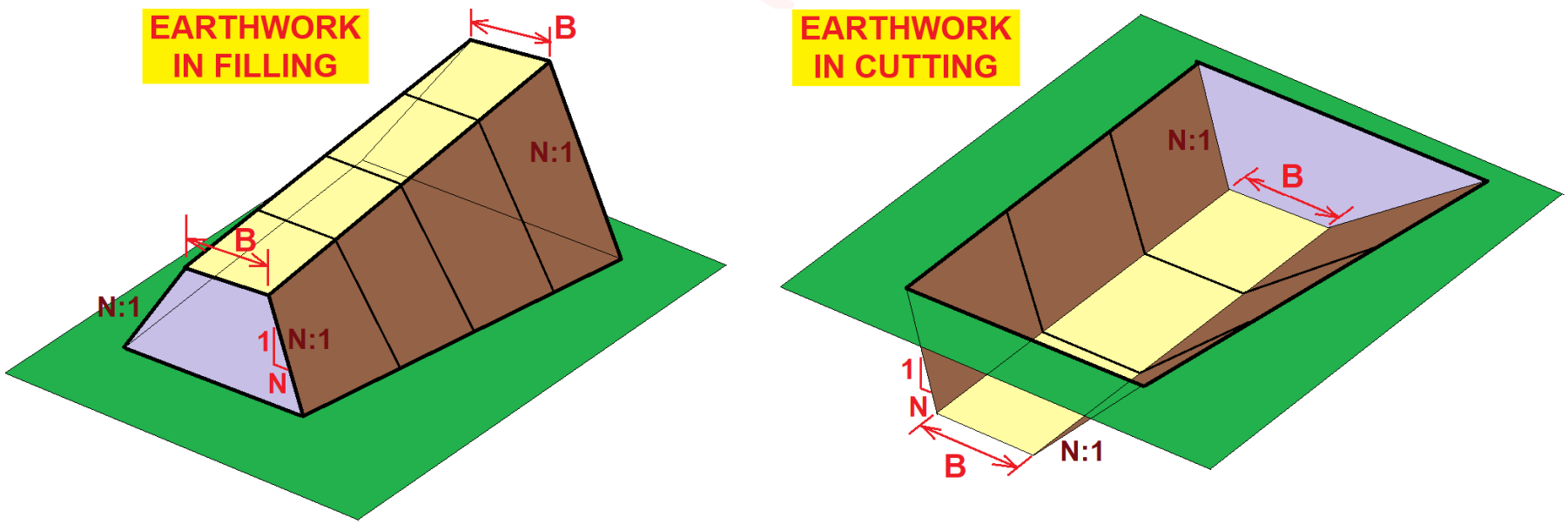




More about Items of Work

Note that,

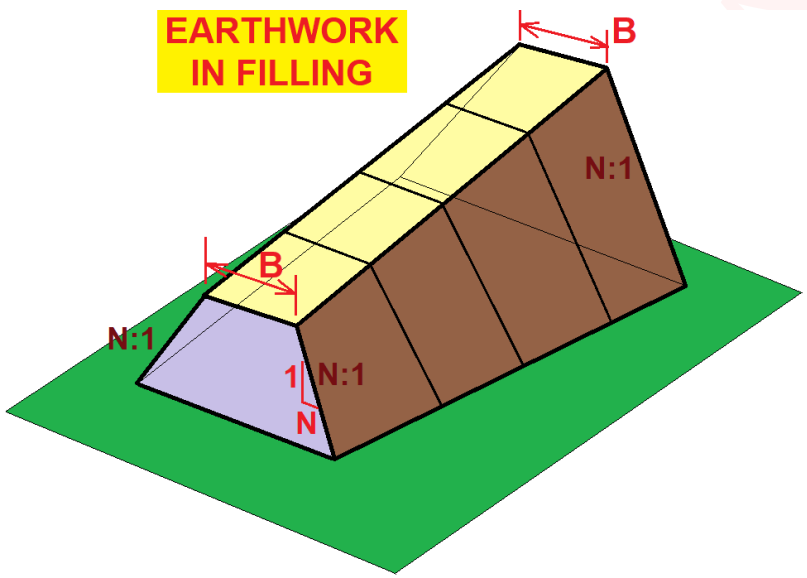
- all the **cross-sections**, including the end-sections, are truly **vertical**.
- **Formation Level** has **only longitudinal slope** and no transverse slope.
- **Ground surface** has **only longitudinal slope** and no transverse slope.

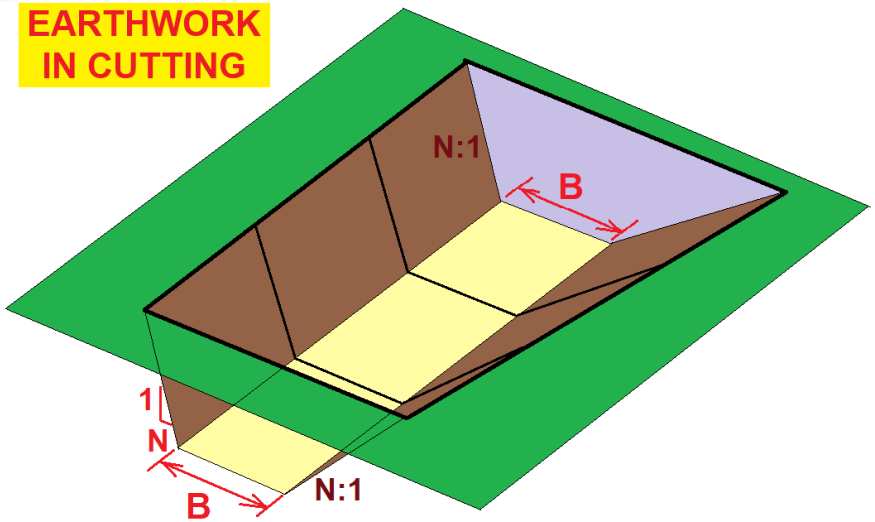


More about Items of Work

Note that,

- For prismoidal earth in **filling**,
  every section is **trapezoidal shape** with the **trough width** a function of **formation width (B)** and **depth (d)**.
- For prismoidal earth in **cutting**,
  every section is trapezoidal shape with the **crest width** a function of **formation width (B)** and **depth (d)**.

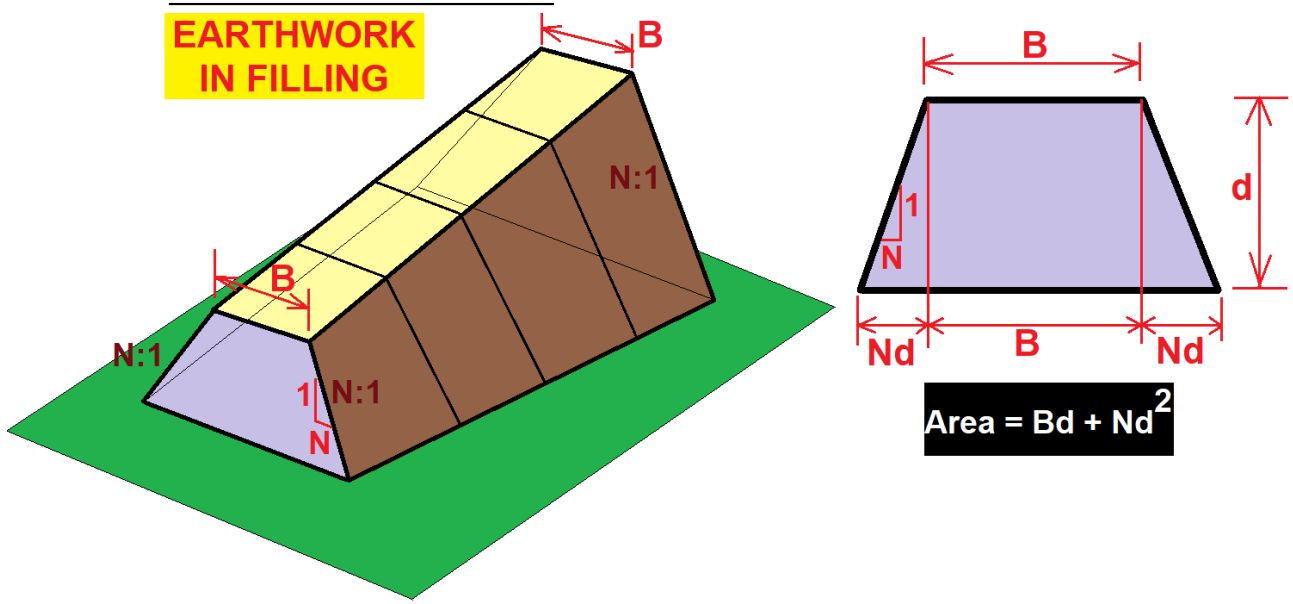




More about Items of Work

- Therefore, for any cross-section
  width of the side opposite to Formation level B is obtained as:
  $= \mathbf{B + 2Nd}$
- Hence, the area of the cross-section becomes:

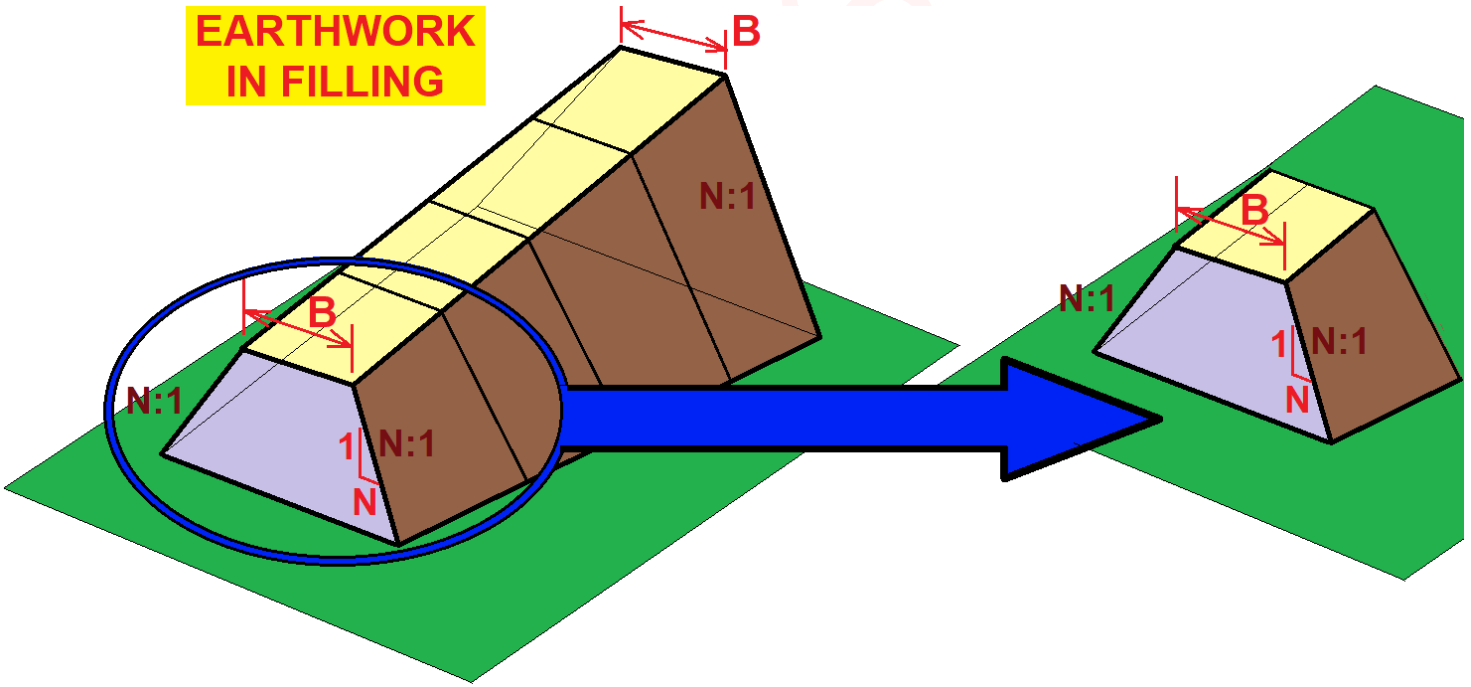
$$\mathbf{A = Bd + Nd^2}$$



- Since **Formation width (B)** and **side slope (N)** are **constants**, as the depth of the section increases, the width of the opposite side of the prismoid (i.e., trough in fill and crest in cut) also increases.

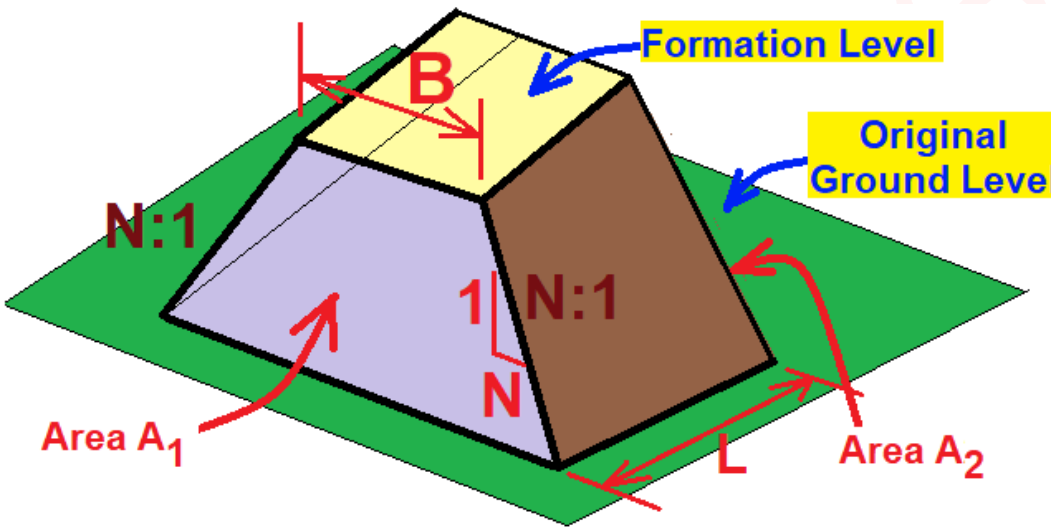
More about Items of Work

As we divided the prismoidal earth into several equally-spaced sections, we shall now consider each segments of prismoid separately.



More about Items of Work

Case 1: Formation level parallel to Original Ground
$\Longrightarrow$ d= constant, for all sections



If the Formation Level is parallel to Original Ground Level, then:

$$A_1 = A_2 = Bd + Nd^2 = A$$

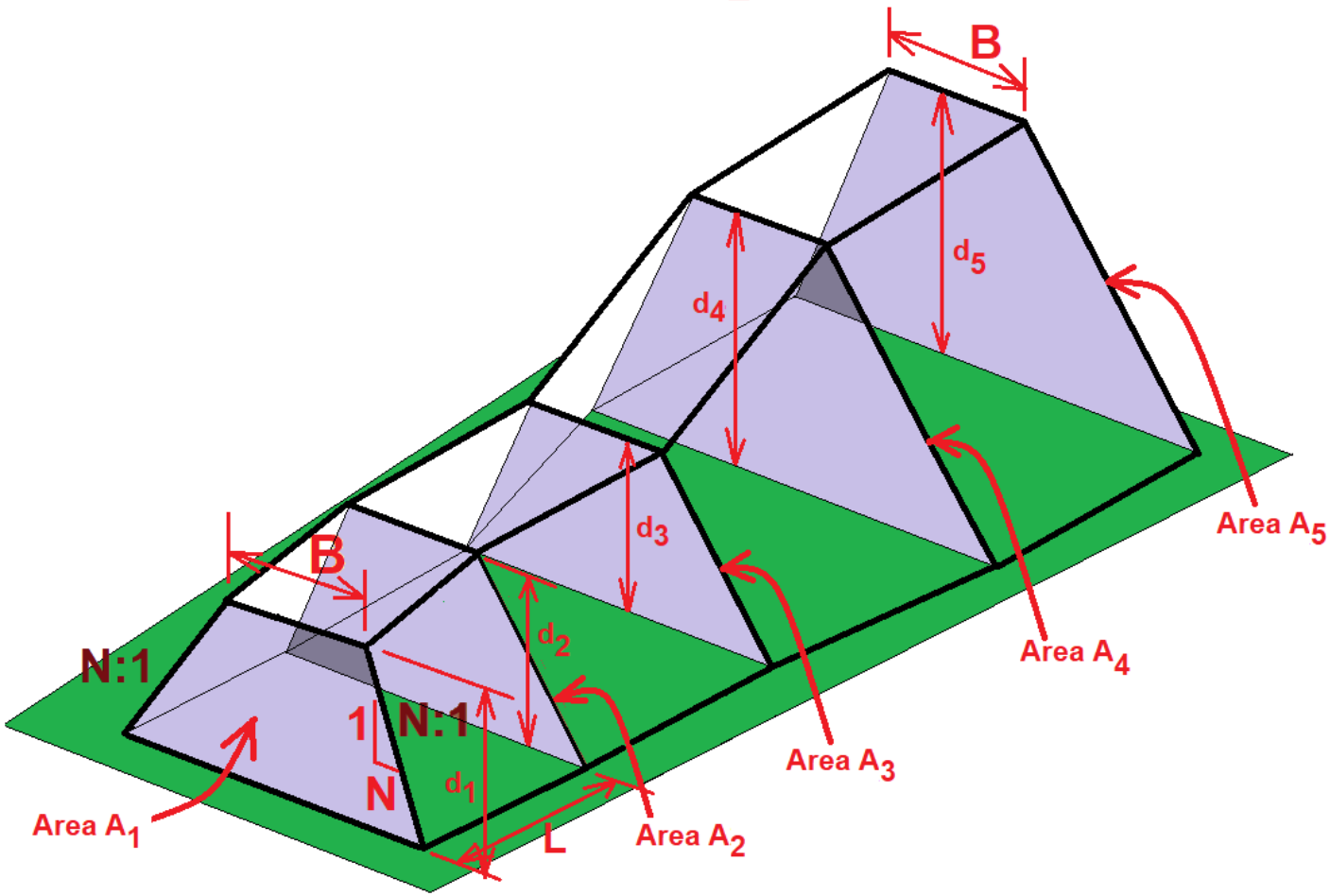
=> Volume of the prismoid (earthwork)
= A x L
= L x ($Bd + Nd^2$)

If k = number of prismoidal segments
= number of sections – 1
then, total volume of earthwork = $\underline{\underline{\mathbf{kL(Bd + Nd^2)}}}$

More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

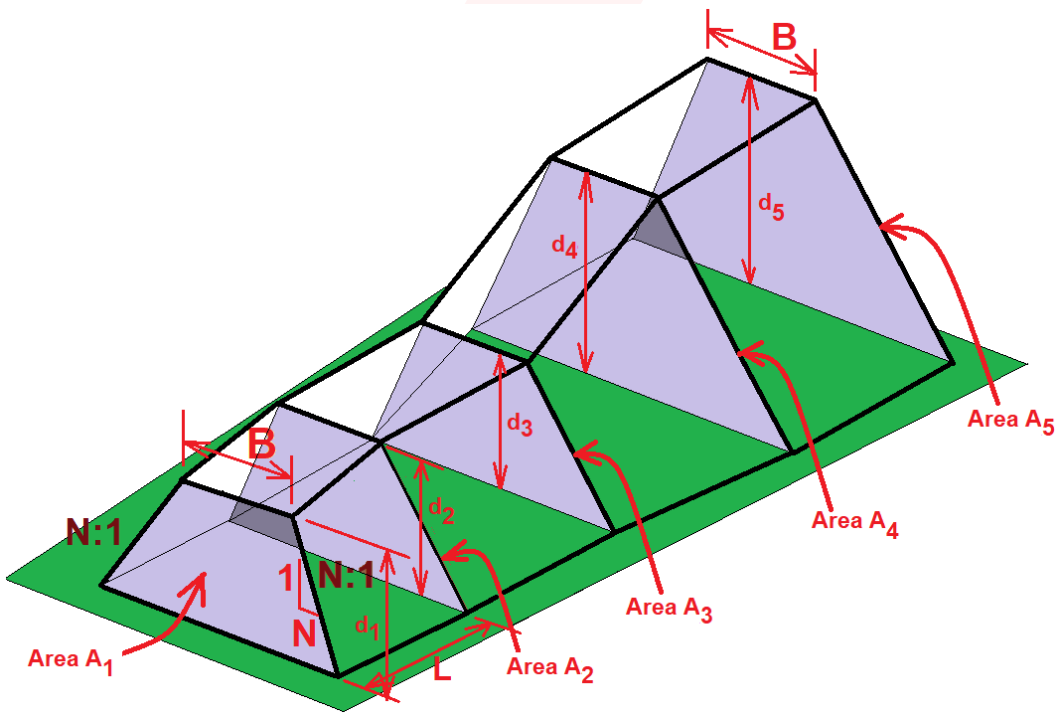
- Here, d varies linearly between adjacent sections, as shown.



More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

- Volume of Earthwork may be determined by any of the following methods.
  1. Mid-section Formula
  2. Average End-area formula (Trapezoidal Formula)
  3. Prismoidal Formula



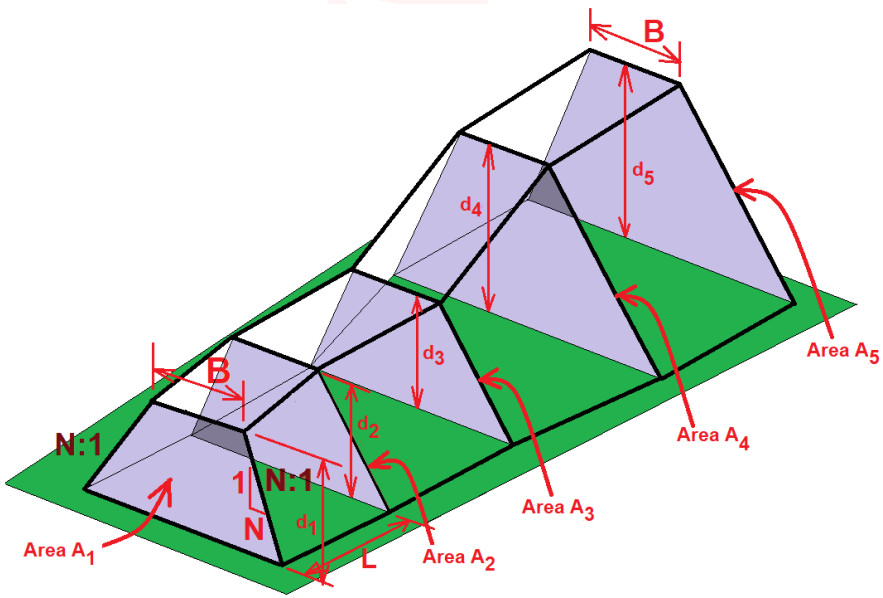
More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

1. **Mid-section Formula:** based on mean depth of the segment, determined by averaging the depth of preceding and succeeding sections of that segment.

   - Mean depth of 1^{st} segment $= d_{m1} = \dfrac{d_1 + d_2}{2}$

     $\Longrightarrow$ Volume of 1^{st} segment $= V_1 = L(Bd_{m1} + Nd_{m1}{}^2)$



More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

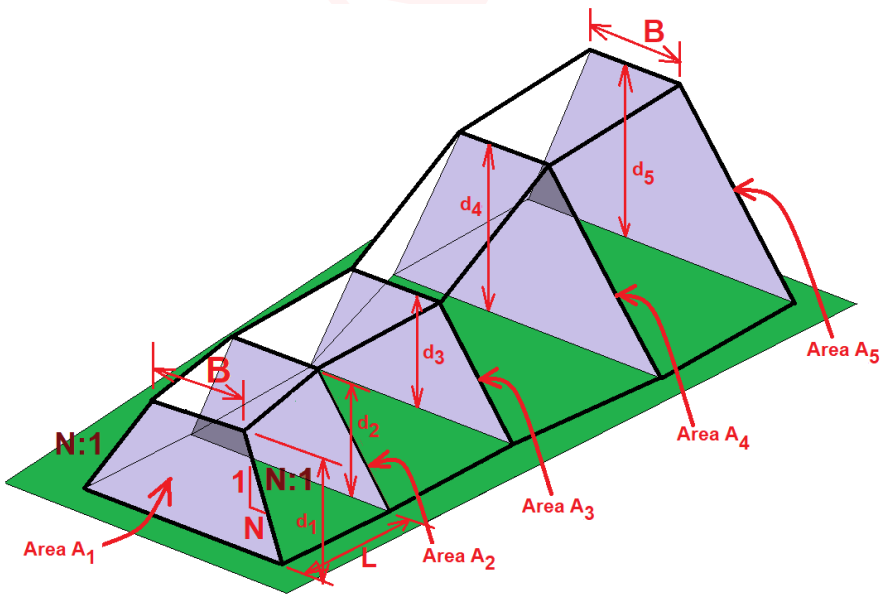
1. **Mid-section Formula**

   - Mean depth of 2^{nd} segment $= d_{m2} = \dfrac{d_2 + d_3}{2}$

     $\Longrightarrow$ Volume of 2^{nd} segment $= V_2 = L(Bd_{m2} + N{d_{m2}}^2)$

     .....can be determined upto k^{th} segment.

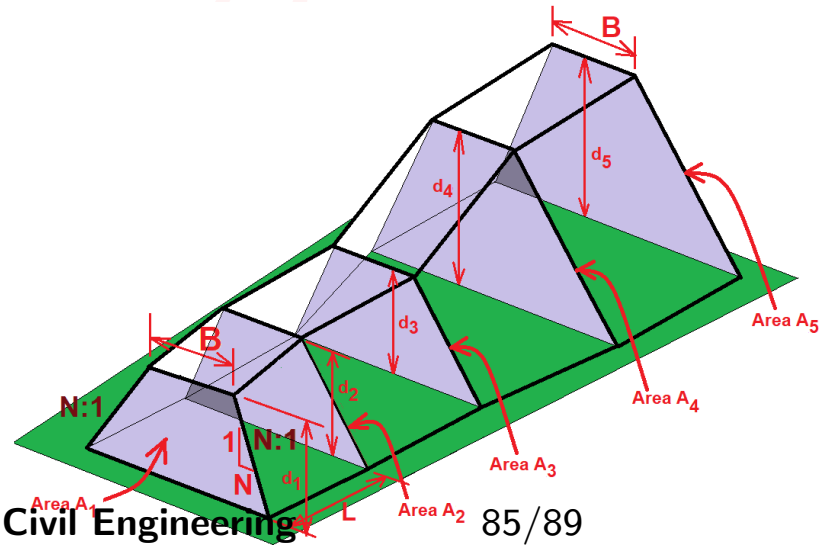
   - Volume of earthwork $\mathbf{V = V_1 + V_2 + V_3 + ... + V_k}$



More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

2. **Average End-Area Formula (Trapezoidal Formula):** based on mean area of the segment, determined by averaging the area of preceding and succeeding sections of that segment.
   - Mean area of 1^{st} segment $= A_{m1} = \dfrac{A_1 + A_2}{2}$
     $\Longrightarrow$ Volume of 1^{st} segment $= V_1 = L\ A_{m1}$
   - Volume of 2^{nd} segment $= V_2 = L\ A_{m2}$
     .....can be determined upto k^{th} segment.
   - Volume of earthwork $\mathbf{V = V_1 + V_2 + V_3 + ... + V_k}$



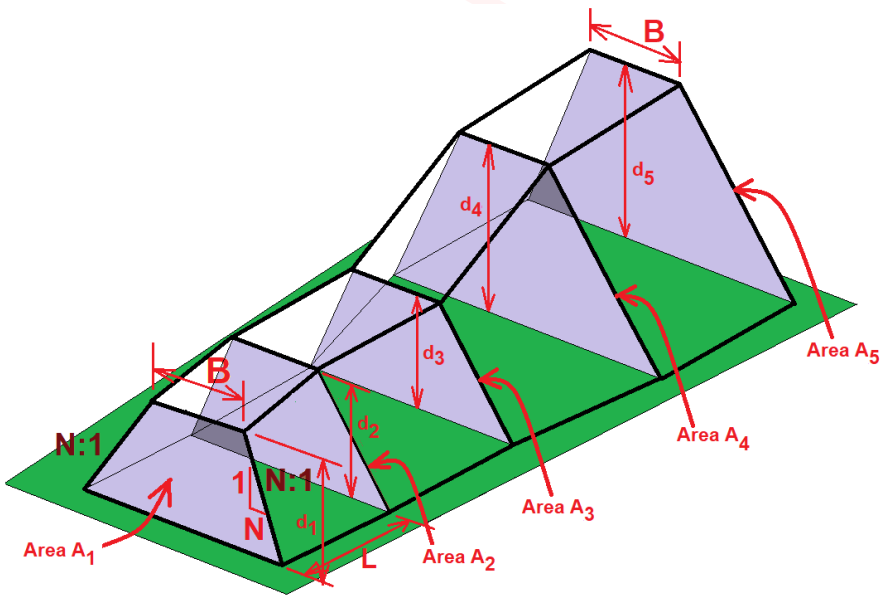
More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

2. **Average End-Area Formula (Trapezoidal Formula):**

- If there are $'k'$ segments, the above equation may be simplified to obtain:

$$\mathbf{V} = \frac{L}{2}(\mathbf{A}_1 + \mathbf{A}_{k+1} + 2(\mathbf{A}_2 + \mathbf{A}_3 + \ldots\ldots \mathbf{A}_k))$$

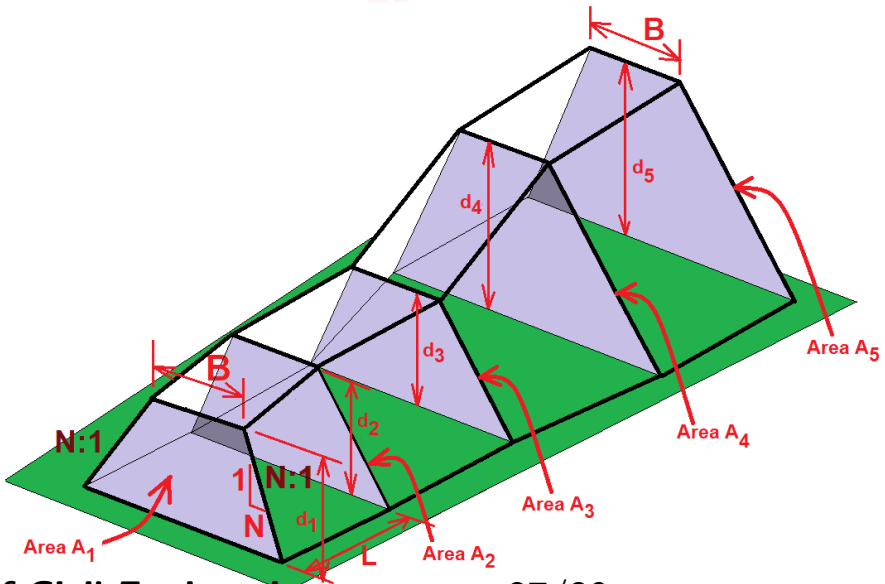


More about Items of Work

Case 2: Formation level inclined to Original Ground in the longitudinal direction

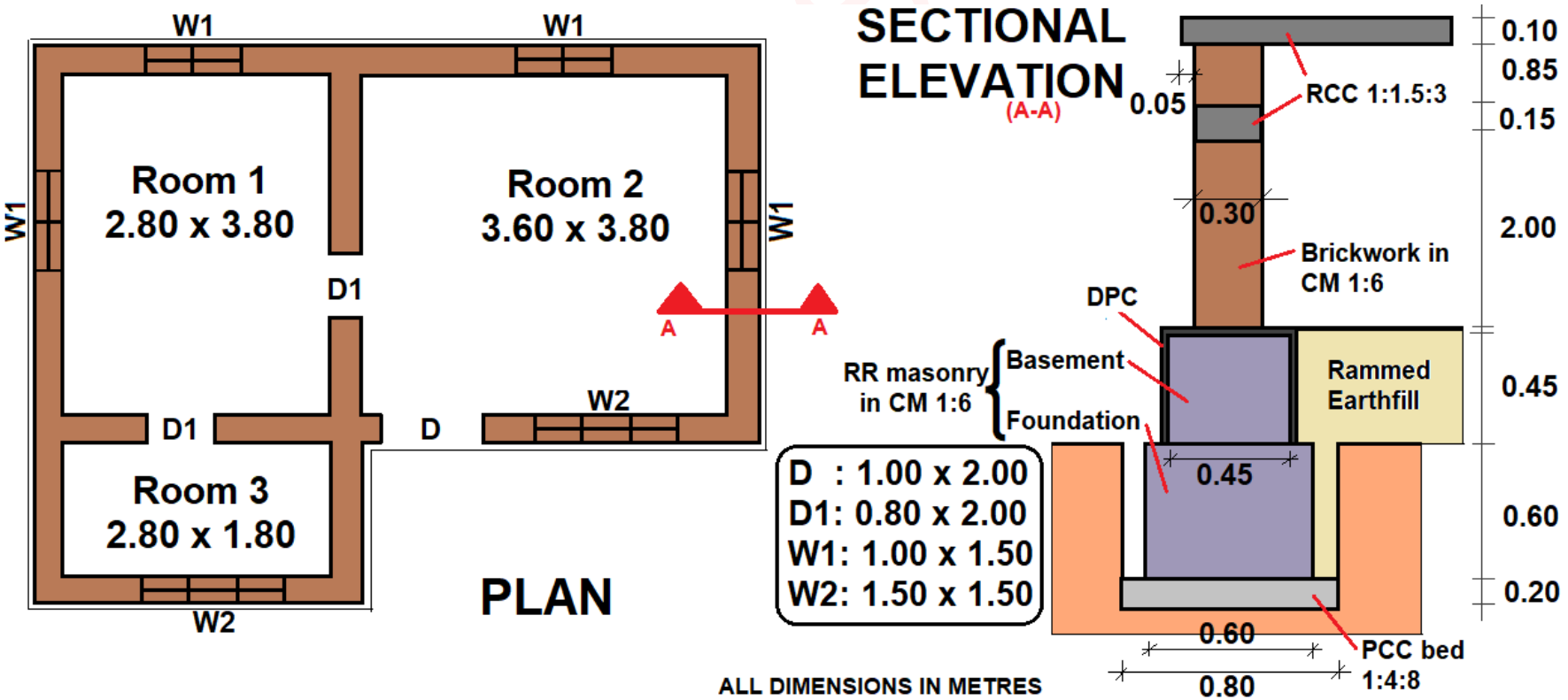
3. **Prismoidal Formula:**
   - This is applicable only in cases of **odd number of sections** or **even number of segments**.
   - In case of even number of sections, the end segment shall be treated separately.
   - According to this, if there are $'k'$ segments, volume of earthwork:

$$\mathbf{V} = \frac{L}{3}(\mathbf{A}_1+\mathbf{A}_{k+1}+4(\mathbf{A}_2+\mathbf{A}_4+.....\mathbf{A}_k)+2(\mathbf{A}_3+\mathbf{A}_5+.....\mathbf{A}_{k-1}))$$



More about Items of Work

For the same building shown in figure, determine the quantities of remaining items of work, based on the recent discussions.



THANK YOU